PREDICTIVE CHARACTERISTICS OF STANDARD DEVIATIONS OF STOCK PRICE RETURNS INFERRED FROM OPTION PRICES

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LIST OF SYMBOLS

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*Where first defined.

Note: Symbols defined and used only within consecutive headings are not included in this list.

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The major objective of this study is to obtain useful information from observations of stock option prices. Traditional approaches have generally attempted to calculate the price at which an option "should" trade. This study attempts to determine the informational content of observed option prices. The observed option prices are used as the input to a model and the stock variability becomes the output.

The secondary objective of this study is to use the variability inferred from the option prices to test the efficiency of the Chicago Board Options Exchange and also the accuracy of the model. The Black-Scholes model, as adjusted for dividends by Merton, is the evaluation model for this study.

An improved method of calculating a collective assessment of stock price volatility from the options on each underlying stock is developed and the change in predictive characteristics of option prices over time is observed. Option prices are found to be superior predictors of future stock return variances than variances obtained from historic stock price data for the period covered by this study.

A riskless trading strategy is developed which allows anticipated gains to be separated into three components:

1. Artifical gains created by option price data which do not properly reflect closing stock prices
2. Artificial gains anticipated as a result of errors in the evaluation model, and
3. Real gains which result from inefficiencies in the option market

The magnitude of each of the three above components are estimated. It is concluded that the option market was inefficient during the observation period (from June 29, 1973 until April 30, 1975) and that the model error was small except for those options which have previously been identified by Merton as potential candidates for overvaluation.

There are several elements in this study which provide important new information:

1. The dividend adjustment and the improved method of calculating a collective assessment of volatility of stock price returns provide better test results than those achieved in previous studies
2. A trading strategy which approaches a riskless process over time can be achieved without requiring a position in the underlying stock
3. The hedging strategy can be implemented without any net investment
4. Use of historic stock price data for construction of option trading strategies will be unproductive if the results of this study are found to be valid in the future

The results obtained indicate that the procedural innovations introduced in this study permit substantial improvements in tests of the evaluation model and of option market efficiency. The improved procedures will allow future empirical research in the above areas to be more productive.

CHAPTER 1
INTRODUCTION

Stock Purchase Options

A stock purchase option is a security giving the right to the owner or buyer of the option to purchase shares of a designated stock at a fixed price until the day the option expires. The price to be paid is called the "exercise price" or the "striking price," and the day the option is to expire is called the "expiration date" or "maturity date." Stock purchase options are often referred to as "call options." Call options are traded in units which give the buyer of the option the right to purchase 100 shares of stock. Listed call options are those which are traded on a regulated option exchange such as the Chicago Board Options Exchange (CBOE). The seller of a call option is usually referred to as the "writer" of the option. A specific option is referred to by expiration month, stock name and exercise price. Thus a January IBM 280 refers to a call option expiring in January which entitles the owner to purchase 100 shares of IBM stock at a price of $280 per share on or before the date of expiration. Call options are originally written to expire in three, six or nine

months. A stock of a given company may have up to three options for each of several different exercise prices. Listed options have standard expiration dates which occur in only four months of the year. All options in this study expire on the last Monday of January, April, July or October. The CBOE permits additional options at different exercise prices to be traded when the underlying stock price approaches a new standard exercise price. Standard exercise prices are at five dollars per share increments for securities selling up to seventy dollars per share, then ten dollars per share on securities priced up to $200 per share after which the increment becomes twenty dollars per share. The new options created as a result of a stock approaching a new standard exercise price expire in less than three, six or nine months in order to coincide with the standard expiration months. Currently the average number of listed options on each stock is approximately ten. An example of a stock purchase option follows:

> On October 13, 1976, a January IBM 280 was selling for $837.50 while the stock was selling for $272.50 per share. Thus some investors were willing to pay $837.50 for the right to purchase 100 shares of IBM stock at $280 per share until the third Friday in January, 1977. (All options expiring in 1976 or later can be

exercised only through the third Friday of the expiration month.) The next day the above option declined to $600, a drop of 29.7 percent while the price of one share of IBM stock had fallen to $264.875, a decline of 2.8 percent. Thus the option buyer had invested an amount of money equal to the price of an option to purchase 100 shares of IBM stock or $837.50. The IBM stock buyer had an investment of $27,250. The loss to the stockholder was $762.50 as compared to $237.50 for the buyer of the option. The option buyer risked less money, but the percentage loss on his investment was greater.

An investor could adjust the number of options sold per 100 shares of stock owned in order to attempt to neutralize the effects of short-term market fluctuations. The gain from the sale of the options sold would tend to offset the loss resulting from the decline in price of his stock investment. In the above example the owner of 100 shares of IBM stock would have had to sell more than three options to offset the loss incurred due to the decline in the price of IBM stock.

The Black-Scholes Model

Publication of the path-breaking papers by Fischer Black and Myron Scholes [1,2] combined with the commencement of option trading on the Chicago Board Options Exchange has generated much interest in option price evaluation. Prior to the introduction of the Black-Scholes model there had been no explicit general equilibrium solution to the option pricing problem. Previous attempts at option evaluation were mostly based on "rule of thumb," graphical or econometric approaches which attempted to predict option prices from historic option price data. The Black-Scholes model differs substantially from previous models. It is the first to determine a "fair value" for an option based on capital market theory.[1]

Black and Scholes [2, p. 643] assume an investor can continuously adjust the number of options sold to offset any instantaneous loss in his stock investment. Therefore the investor can achieve a risk-free investment and should not be able to create profits in excess of the risk-free rate. Black and Scholes claim that even if the investor does not continuously adjust the number of options sold he

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[1]For the reader interested in the history and the development of earlier option evaluation techniques I recommend The Stock Options Manual by Gary L. Gastineau, published by McGraw-Hill late in 1975. The book contains an annotated bibliography. Each reference is augmented by a concise summary indicating the level of difficulty and an evaluation of the relative merit of the contents.

may still be able to achieve a risk-free investment by diversifying his assets among many stocks and their options.

In our example using IBM stock and options with the price change taking place in only one day a "theoretically correct" hedge would have produced the risk-free rate of return for a one-day period. The decline in price of the options sold would have exceeded the loss on the IBM stock investment by an amount necessary to achieve one day's interest at the risk-free rate on the net dollar investment.[1]

The assumptions underlying the Black-Scholes model are as follows:

1. There are no penalties for short sales
2. Transactions costs and taxes are zero
3. The market operates continuously
4. The risk-free interest rate is constant
5. The stock price is continuous
6. The stock pays no dividends
7. The option can only be exercised at maturity

The option formula of Black and Scholes is:

$$W = XN(d_1) - Ce^{-rt}N(d_2)$$

where: $$d_1 = \frac{\ell n(X/C) + (r + \frac{1}{2}v^2)t}{vt^{\frac{1}{2}}}$$

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[1]The net dollar investment is the value of the stock minus the proceeds from the sale of the options.

$$d_2 = d_1 - vt^{\frac{1}{2}}$$

W = the current option price for a single share of stock

X = the current stock price

C = the exercise price of the option

e = the base of natural logarithms

t = the time remaining until expiration of the option

r = the continuous risk-free rate of interest for the period t

v = the standard deviation of returns on the stock during the period t (assumed to be constant)

N(.) = the cumulative normal density function of (.).

Thus one must observe only five parameters to compute the equilibrium option price:

1. The stock price
2. The time to maturity
3. The exercise price
4. The risk-free interest rate
5. The standard deviation of future returns on the stock[1]

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[1]Black and Scholes [2, p. 640] assume the stock price distribution is log-normal. The logarithms of the price

The last parameter cannot be observed. The past history is of some help in the estimation of future standard deviations, but changes over time do occur. The first three parameters are directly observable and a proxy such as the treasury bill rate may be used for the risk-free rate. Since the option price can also be observed, the expected future standard deviation of returns on the stock may be inferred by calculating the value of v which is expected in order to justify the option price. The value of v inferred by calculation for each option price is called the implied standard deviation (ISD). The predictive characteristics of the implied standard deviations (ISDs) of option prices are the major focus of this study.

Extensions of the Model

The assumptions of the Black-Scholes model appear to create severe restrictions which limit its usefulness. However, the research of Merton [7, 8, 9], Cox and Ross [3] and Ingersoll [4] has aided in indicating that no single assumption appears to be crucial to the analysis.

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ratios must be obtained before calculation of standard deviations. The term "standard deviations" as used in this study refers to those of the logarithms of the stock price ratios.

Dividend Adjustment

Dividends on some stocks may be substantial compared to the risk-free rate and can have a significant effect on the valuation of options whose stocks make such payments during the life of the options. Merton [7] adjusts the Black-Scholes model for a specific dividend policy. Dividends are assumed to be paid continuously such that the yield is constant. Smith [10; p. 26] presents an altered version which corrects a minor discrepancy in Merton's presentation. The form of the evaluation equation follows:

$$W = e^{-yt} X N(d_1) - e^{-rt} C N(d_2)$$

where: $$d_1 = \frac{\ln(X/C) + (r - y + \tfrac{1}{2}v^2)t}{vt^{\frac{1}{2}}}$$

$$d_2 = d_1 - vt^{\frac{1}{2}}$$

y = the continuous yield on the stock or the dollar value of the dividend divided by the stock price.

The model above does not conform to actual dividend policies of firms. To apply Merton's model it is necessary to convert discrete payments to an equivalent continuous rate. Although payments are not made at a constant rate, this assumption appears more reasonable than ignoring dividends entirely. At present there is no known solution to the option pricing equation for a discrete dividend payment.

The existence of a discrete dividend payment may cause the option holder to exercise his option prematurely. An option which is most likely to be exercised before maturity would have a high dividend yield, an ex-dividend date just prior to its expiration date and an underlying stock price well above the option's exercise price. Consider the holder of an option who wishes to exchange the asset for cash. He may either sell the option or exercise it to receive the dividend before selling the stock. When the invester exercises instead of selling he loses the premium in excess of the intrinsic value.[1] Therefore in order to benefit from early exercise the option holder must receive a dividend on the stock which exceeds the loss of the excess premium plus the cost of the transactions.[2] Because of the above factors which tend to minimize the occurrence of early exercise, the errors resulting from this source are not expected to be significant.

The evaluation model for this study is the Black-Scholes model as adjusted for dividends by Merton. The processing of initial data indicates that the model as adjusted for dividends produces more consistent and realistic standard deviations of stock returns than the model as presented by Black and Scholes.

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[1]Intrinsic value of an option is the excess of the stock price relative to the option exercise price.

[2]In addition, the stock price will decline on the ex-dividend date.

Discontinuous Stock Price Movements

Cox and Ross [3] and Merton [8, 9] examine discontinuous stock price movements. Their findings are consistent with observations from this study. The violation of this basic assumption of the model does not result in significant errors except for options which have short remaining lives or for those on stocks with prices far below the exercise price [9, p. 343]. A more detailed discussion of the effects of discontinuous stock price movements is presented in Chapter 3.

Tax Effects

Ingersoll [4] considers the effect of taxes in his paper which applies option evaluation techniques to closed-end mutual funds. He finds that better results can be obtained by adjusting the option evaluation model for income taxes. He is also one of the first to use dividends as a parameter in the model enabling him to examine the pricing of dividend and capital shares of dual purpose funds.[1]

The above studies all show the Black-Scholes model to remain useful under the relaxation of several basic assumptions.

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[1]Dual purpose funds have two classes of shares. Dividend shares are entitled to the total net dividends received on all assets of the fund. Capital shares are entitled to receive the total of all net capital gains.

Other Related Studies

Latané and Rendleman

Latané and Rendleman [6] have presented results based on the implied standard deviations of stock returns as obtained by use of the Black-Scholes model and CBOE options. They calculated a weighted average of the ISDs as a measure of market forecasts of return variability. The rationale for their use of a particular weighting function is explained in the following manner:

> It would be unreasonable to expect option prices for a given company to reflect the arithmetic average of implied standard deviations from all options on its stock which are traded in a particular point in time. The ISDs on those options whose prices are the least sensitive to a precise specification of the standard deviation are likely to be unrepresentative of the market's underlying expectation. Implied standard deviations on such options could take on a wide range of values within a narrow range of option prices, and accordingly, should not be given as much weight as ISDs of options in which the standard deviation is a more important factor. Therefore, we use a weighted average implied standard deviation (WISD) in which the ISDs for all options on a given underlying stock are weighted by the partial derivative of the B-S equation with respect to each implied standard deviation. [6, p. 371]

However, the weighting formula presented was found to conflict with the above explanation. The following formula was described by Latané and Rendleman [6, p. 371]:

$$WISD_{it} = \left(\sum_{j=1}^{N} ISD_{ijt}^{2} \cdot d_{ijt}^{2}\right)^{\frac{1}{2}} \left(\sum_{j=1}^{N} d_{ijt}\right)^{-1}$$

where: $WISD_{it}$ = weighted average implied standard deviation for stock i in period t

ISD_{ijt} = implied standard deviation for option j of stock i in period t

d_{ijt} = partial derivative of the price of option j of stock i in period t with respect to its implied standard deviation using the Black-Scholes model.

A simple example illustrates the error in the use of the above weighting function:

Given two options on a single stock, both options having the same implied standard deviation of monthly returns (ISD_{ijt}) and partial derivative (d_{ijt}) of 0.10 and 1.0 respectively, the following WISD for period t would be calculated:

$$WISD = (0.01X1.0+0.01X1.0)^{\frac{1}{2}}(1.0+1.0)^{-1}$$

$$= (0.02)^{\frac{1}{2}}(2)^{-1}$$

$$= 0.0707$$

Although both options implied the same standard deviation of returns on the stock, the weighting formula of Latané and Rendleman produced an implied standard deviation of

returns which is biased toward zero.[1] If a larger number of options were traded on a particular stock the standard deviation implied by the formula would approach zero as a limit.

Using the biased weighting formula Latané and Rendleman explored the usefulness of the WISDs in predicting future standard deviations of stock returns. The WISDs and two sample historic standard deviations (a four-year period prior to the WISD observation period and a 38-week sample of the observation period) were compared to a two-year sample taken after the WISD observation period. They also constructed weekly hedges between stocks and their options. First they used "underpriced" and then "overpriced" options and compared the returns from both types of hedges with the risk-free rate to obtain a measure of "excess returns."[2] A critical assumption in their study and in this study is that option prices behave as if they are generated by the relevant valuation model.

Latané and Rendleman concluded that the WISD is generally a better predictor of future return variability than sample historic standard deviations. They also reported that tests of their trading model "suggest" that the Black-Scholes model can be used in determining whether

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[1]The values of ISD_{ijt} and d_{ijt} are always equal to or greater than zero.

[2]The return on a treasury bill was used as the standard for the risk-free rate.

individual options were properly priced for short-term riskless hedging [6, p. 381].

Although WISDs were calculated for a 38-week period, there was no attempt to test the predictive characteristics of options observed at any one point in time. All the WISDs were averaged together for each stock during the 38-week period of the study.[1] There were 24 stocks in the sample. The aggregation of the data permitted only one comparison between each of the predictors of future standard deviations of returns for the 24 stocks.

Latané and Rendleman state that many observations of option prices produced non-meaningful standard deviations as solutions to the Black-Scholes formula and that such data was discarded. They found that a standard deviation of zero was not low enough to enable one to calculate the observed option price. Merton's dividend-adjusted model frequently provides realistic standard deviations for those options.

The current study examines the predictive characteristics of WISDs for each observation date. A different weighting formula for obtaining WISDs is used. The improved formula is discussed in Chapter 2.

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[1]Beginning October 5, 1973 and ending June 28, 1974.

<u>Trippi</u>

A recent study by Robert R. Trippi [11] pursued an investment strategy to test the efficiency of option trading on the Chicago Board Options Exchange. The ISDs of option prices were calculated by a process similar to that used by Latané and Rendleman. Ninety-day certificates of deposit were used as a proxy for the risk-free rate instead of rates of U.S. Treasury bills maturing closest to each option expiration date. Trippi calculated an arithmetic average of the ISDs to obtain a "collective assessment of volatility" for each stock. Latané and Rendleman had previously labeled the use of such an arithmetic average as "unreasonable." Selection of options was narrowed by the following exclusions:

(a) Options with premiums of less than $1.00

(b) Options with less than three weeks of remaining life, and

(c) Options with premiums less than 1.3 times the stock price less the exercise price [11, p. 95]

The reason for the above exclusions follows:

> . . . the valuation model does not work well with very cheap options (transactions costs become substantial), with those having very short remaining lives, or with those that are very deep in the money. [11, p. 95]

An implied market value was computed by insertion of the collective assessment of volatility into the Black-

Scholes equation and calculating the resulting option price. The calculated price must differ from the observed price in order to permit a profit opportunity. The following decision rule was used to construct portfolios of options for one-week holding periods [11, p. 95]:

> Long portfolios are to include all options whose prices are more than 15 percent below the implied market value and short portfolios are to include all options whose prices are 15 percent above the implied market value.[1]

Trippi assumed that within one week the options would approach values which would substantially reduce the differences between their prices and their implied market values.

Four hundred three options were selected for the portfolios during the test period, 202 long positions and 201 short positions. The average weekly return on the total market value of the long and short positions was 10.8 percent.

Trippi also conducted tests to determine whether it was possible to have executed the profitable transactions. Option prices were examined in detail from April 7 through April 25, 1975. The following day's opening prices were

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[1]Given no initial position in an option the buyer is considered "long" the option and the seller considered "short" the option.

observed to determine whether favorable option prices continued to exist. Trippi states:

> . . . it appears that the initiation of options positions at the closing prices or their equivalents would have been frequently possible. [11, p. 97]

A more detailed discussion of Trippi's test is presented in Chapter 3. Trippi concluded that the option market (CBOE) could have allowed one to realize large profits after commission costs during the period covered by his study.

Conclusions

Previous studies by Latané and Rendleman and Trippi have investigated option prices for predictive characteristics which permit construction of profitable trading strategies. Weaknesses in the studies have been noted and remedies have been suggested to improve the test procedures in order to increase the potential rewards of further research.

A test of the predictive characteristics of option prices as related to the price movements of their underlying stocks is presented in Chapter 2. Better results are achieved by the addition of three major factors:

1. The use of an improved formula for the calculation of weighted implied standard deviations
2. The use of an evaluation model which permits an adjustment for dividends

3. The use of a test procedure which allows observations of the changes in predictive characteristics of option prices over time

A trading strategy similar in principle to that of Trippi is developed in Chapter 3. However, there are four major differences in procedure which improve the returns and expand the domain of eligible options beyond the boundaries of Trippi's exclusion rules:

1. Dividends are included as a variable in the evaluation equation
2. The formula for weighting ISDs is improved
3. The trading rule creates risk-free hedges in lieu of portfolios of options with unknown risk
4. Many options for which Trippi claimed ". . . the valuation model does not work well . . ." are included

Chapter 4 contains a summary and the conclusions of this work.

CHAPTER 2
PREDICTIVE CHARACTERISTICS OF OPTION PRICES

Implied Standard Deviations

One popular method of option price evaluation requires an estimate of the historic standard deviation of returns on a stock (SDHIST). That estimate is then used to calculate an equilibrium option price from an option evaluation formula.[1] An implicit assumption underlying the above procedure is that the SDHIST is the best available estimate of the future standard deviation of stock returns. If equilibrium market prices reflect a more accurate estimate of future standard deviations of stock returns, the above method of option evaluation would not be useful in the calculation of "fair" values for stock options. The difference between the observed and the calculated option price would reflect the difference between the estimated SDHIST and the aggregate market measure of expected future standard deviation of returns and not, as some option traders believe, a profit opportunity. The use of historic price data to construct trading rules for options would be

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[1]As stated in Chapter 1, returns are expressed as price ratios and the standard deviations of those price ratios are used in option evaluation formulas.

ineffective (except for those individuals who received the commissions generated by such an unproductive procedure). If option prices contain information which can be used to calculate better indicators of future stock return variances than the estimates obtained from historic stock price data, that information may be of substantial value to stock or option traders. The procedure for obtaining estimates of future standard deviations of stock returns would be simplified. One would need only to examine the current option price instead of processing numerous historic stock price data. The current option price when entered into the evaluation equation would permit the calculation of the standard deviation inferred from the market price. In this study that value obtained by use of the current option price is called the "implied standard deviation" (ISD).

Weighted Implied Standard Deviations

During the period encompassed by this study there was an average of 6.3 option prices recorded per stock for each observation date. Each of those options had a different ISD. The ISDs must be combined in order to produce a single estimate of future standard deviation of returns for each stock. In Chapter 1 we examined the attempt of Latané and Rendleman to combine ISDs to produce WISD values. Although they presented a biased weighting function, their

reasoning for not accepting an arithmetic average of the ISDs is sound. There are considerable differences in the sensitivities of option prices to changes in expected stock return variances. An example follows:

> For a nine-month option on a stock selling at 70 percent of the option's exercise price with an implied standard deviation of monthly returns equal to 0.03626, a 50-percent increase in the implied standard deviation to 0.05439 would result in a calculated 487-percent increase in the option price. Under the same circumstances but with the stock price at 130 percent of the option's exercise price the calculated option price obtained by use of the model will increase only 4 percent.[1]

Latané and Rendleman had intended to weight the ISDs by the partial derivatives of the Black-Scholes model with respect to each implied standard deviation. That is equivalent to weighting ISDs according to the sensitivity of the dollar price change for the options relative to the incremental change in the implied standard deviation. A rational investor measures returns as the ratio of the dollar price change to the size of the investment. The reasoning of Latané and Rendleman emphasizes the total dollar return

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[1]A risk-free rate of 6 percent is assumed.

without regard to the size of the investment.[1] In order to be consistent with a rational measure of returns the price elasticity of options with respect to their ISDs must be considered. We must be concerned with the percentage change in the price of an option with respect to the percentage change in its ISD.

The equation used to obtain the weighted implied standard deviation of the options on one stock for each observation date is

$$WISD = \frac{\sum_{j=1}^{N} ISD_j \frac{dW_j}{dv_j} \frac{v_j}{W_j}}{\sum_{j=1}^{N} \frac{dW_j}{dv_j} \frac{v_j}{W_j}}$$

$j = 1,2,\ldots,N$

N = The number of options recorded on a particular stock for the observation date

where:

WISD = the weighted implied standard deviation for a particular stock on the observation date

ISD_j = the implied standard deviation of option j for the stock

$\frac{dW_j}{dv_j} \frac{v_j}{W_j}$ = the price elasticity of option j with respect to its implied standard deviation (v).

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[1]A one-dollar price change on a one-dollar stock is considered equivalent to the same price change on a fifty-dollar stock.

The Hypothesis

A test of the following hypothesis will aid in the determination of the predictive characteristics of stock option prices:

> STANDARD DEVIATIONS INFERRED FROM OPTION PRICES HAVE BEEN BETTER PREDICTORS OF STANDARD DEVIATIONS OF FUTURE STOCK RETURNS THAN STANDARD DEVIATIONS OBTAINED FROM HISTORIC STOCK RETURNS.

If the hypothesis is accepted one may suspect that option prices can provide a valuable source of information relative to the variance of future stock returns. If the latter fact can be confirmed by the results of future research, the use of historic stock price data to implement profitable trading rules for options will be discredited and many unsuspecting investors may be spared the associated expenses and futility.

Historic stock returns are readily available and it is likely that such information is part of the data assimilated by the market. It is possible that other current information may aid in the estimate of future standard deviations of stock returns. One may suspect that market prices reflect future standard deviations more accurately than historic sample data. If not, use of historic models would allow one to obtain greater than "normal" returns in the

option market. In the latter case the option market would be suspected of being inefficient. The alternative conclusion would be that the evaluation model was not sufficiently accurate to allow useful calculations of option values. The model may be used to discover inefficiencies even if the hypothesis is accepted. A trading rule is developed in Chapter 3 to test for discrepancies in pricing among individual options on the same underlying stock.

Criteria for Selection of Data

There are considerations which necessitate restrictions in the selection of data:

1. Observations of option and stock prices which are not well correlated in time. Data are recorded at the close of the last trading day of each month; it is likely that some option prices do not accurately reflect the closing stock price because of the lack of a transaction after the last stock price change.
2. The process by which options attain equilibrium price may be inhibited by transactions costs. The effect is more pronounced for the lowest priced options as transactions costs are a substantial

percentage of their market price. Options with little time remaining to maturity will have large transactions costs relative to their premiums which may prevent them from attaining equilibrium prices

In order to minimize the errors created by the above factors the following selection criteria will be used:

1. Options which trade below their intrinsic values are deleted from this study.[1] These options are probably not reflecting the actual closing price of the underlying stock for if they were the discount would be arbitraged away by a trader who owns a seat on the exchange
2. Options with a remaining life of less than twenty-four days are not observed due to the method of selecting the observation dates for option prices. The options expire on the last Monday of the exercise month and observations are taken as of the last trading day of each month
3. Options selling below $0.50 whose underlying stock price is more than $5.00 below

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[1]Intrinsic value is the excess of the stock price relative to the option exercise price.

the option's exercise price are deleted from this study. The Chicago Board Options Exchange prohibits establishing a new position either as a buyer or seller in such options

Data

There are 23 monthly observation periods (t) beginning June, 1973 and ending April, 1975. Data are recorded for the last trading day of each month for each option on stocks whose options were traded on the Chicago Board Options Exchange as of June 29, 1973. Data recorded on each date are

1. The discounts on the U.S. Treasury bills which mature closest to the standard option exercise dates
2. The closing price of each underlying stock
3. The number of days to the standard exercise dates
4. The standard exercise prices
5. Values unique to each option:
    a. The closing price
    b. The dividend that the underlying stockholder is entitled

to receive as a result of
his ownership up to the
exercise date

6. The monthly price ratios of each underlying stock for each twenty-month period preceding and following each observation date.[1]

For 1, 2, 4 and 5a above the data are recorded directly from the Wall Street Journal. For number 3 the standard exercise month is recorded and the number of days are calculated. The U.S. Treasury bill discount rate is converted to an equivalent continuous interest rate. The values for 5b are taken from Moody's Handbook of Common Stocks published by Moody's Investors Service, Inc.[2] The dividends are converted to an equivalent continuous rate. For number 6 above the stock return data are taken from the computer tapes available from the Center for Research in Security Prices at the University of Chicago. The logarithms of the monthly price ratios are computed and the sample standard deviations of the logarithms of monthly ratios are calculated for the twenty-month period preceeding and following each observation date. From the data in 1 through 5

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[1]The monthly price ratio is the price at the end of the month divided by the price at the end of the previous month. Ratios have been corrected for stock distributions other than dividends.

[2]It is assumed that the market's forecast of dividends is perfect during the life of each option. Analysis of final data indicates that such an assumption is not crucial to this study.

above an implied standard deviation (ISD) for each option can be calculated by the use of an iterative search process.[1] The weighted average of the ISDs for each stock on each observation date is calculated by use of the equation presented on page 22 which eliminates the bias present in the formula used by Latané and Rendleman. The weighted average of the implied standard deviations (WISD) of a particular stock is assumed to be the collective assessment of the expected future standard deviation of returns on the stock.

Test Procedure

The following graph and linear regression equations aid the explanation of test procedures for Hypothesis 1.

$SDHIST_{i,t}$	$WISD_{i,t}$	$SDFUT_{i,t}$	$i = 1,2,\ldots,23$
$t-20$	t	$t+20$	$t = 1,2,\ldots,23$

$$SDFUT_{i,t} = a_h + B_h SDHIST_{i,t}$$

$$SDFUT_{i,t} = a_o + B_o WISD_{i,t}$$

[1]It is impossible to solve the evaluation equation directly for the ISD. By use of the partial derivative of the option price with respect to its implied standard deviation the value of the ISD is altered until the calculated option price is within $0.001 of the observed option price. Convergence is rapid, sometimes requiring only three iterations.

$$SDFUT_{i,t} = a_c + B_{ch}SDHIST_{i,t} + B_{co}WISD_{i,t}$$

where:

$WISD_{i,t}$ = the weighted implied standard deviation of returns for stock i at time t

$SDHIST_{i,t}$ = the sample historic standard deviation of returns for stock i from time t-20 to time t

$SDFUT_{i,t}$ = the sample standard deviation of returns for stock i from time t to time t+20

a_h and B_h = coefficients of the simple regression model for $SDFUT_{i,t}$ versus $SDHIST_{i,t}$

a_o and B_o = coefficients of the simple regression model for $SDFUT_{i,t}$ versus $WISD_{i,t}$

a_c, B_{ch} and B_{co} = coefficients of the multiple regression model for $SDFUT_{i,t}$ versus $SDHIST_{i,t}$ and $WISD_{i,t}$.

The SDHISTs and the WISDs are compared to the SDFUTs to determine which predictor was superior during the test period. The period examined began two months after the start of listed option trading and lasts for 22 months (23 observations). The data allows one to compare the predictive abilities of option traders at various stages of the development

of the listed option market. The combination of SDHISTs and WISDs are also compared to the SDFUTs to determine whether each predictor provides unique information or contains only information already captured by the other. The values of SDHIST, WISD and SDFUT are presented in Appendix A.

Observations on the Processing of Data

While calculating ISDs to obtain the WISD values for the regression models, several items of interest were discovered. The use of the dividend adjusted model increased the value of the ISD calculated for each option on which the dividend adjustment was relevant. Most option data which previously had produced no solution for an ISD by insertion into the Black-Scholes model now enabled one to produce meaningful ISD values. For options on stocks with high yields and low WISD values the effect was most pronounced. The ISDs now had less variation and the method used to discover and to correct erroneous data was simplified. By scanning ISD values for each stock significant data errors could often be detected by selection of those options whose ISDs were inconsistent with those of other options on the same stock. The most inconsistent ISDs were discovered on options which violated the CBOE rule for the establishment of a new position (short or long). Those

options have been eliminated from this study. The second most common inconsistency was found on options whose stocks were selling substantially above the option exercise price. Those options, as noted in a previous example, are not very sensitive to changes in expected standard deviation. The weighting function effectively eliminates their impact on the WISD values calculated. Thus it is possible to base this study on an improved evaluation formula and a better weighting function for WISDs which do not require the exclusion of as much option data as was necessary in the research of Trippi and that of Latané and Rendleman.

Test Results

The estimate of the intercept (a) and slope coefficient (B) and their standard errors (SEs) are presented in Tables 1 and 2 for the linear regression models SDFUT = a + B(SDHIST) and SDFUT = a + B(WISD). Values of R^2 and the t statistic for B are also included. Subscripts have been deleted to simplify presentation of data. Values are recorded for each model for every month. Data were observed for twenty-three stocks on each date. The values of SDHIST, WISD and SDFUT were calculated for each stock. The SDHIST and the WISD values were compared to the SDFUT values to determine which of the two was the better predictor of the SDFUT values.

Table 1

Results for the Regression
SDFUT = a + B(SDHIST)

Month	a(SE)	B(SE)	t*	R^2
1	.205(.07)	.776(.25)	3.00**	.30
2	.232(.06)	.622(.20)	3.08**	.31
3	.224(.06)	.653(.20)	3.23**	.34
4	.226(.06)	.662(.22)	2.98**	.30
5	.235(.07)	.640(.24)	2.70**	.26
6	.284(.06)	.348(.19)	1.84	.14
7	.277(.06)	.357(.19)	1.92	.15
8	.269(.06)	.377(.18)	2.08	.17
9	.288(.06)	.326(.18)	1.80	.13
10	.277(.06)	.368(.18)	2.04	.17
11	.271(.06)	.386(.18)	2.14	.18
12	.268(.05)	.402(.16)	2.47	.23
13	.264(.05)	.413(.16)	2.51**	.23
14	.238(.06)	.443(.16)	2.71**	.26
15	.236(.06)	.430(.16)	2.63**	.25
16	.181(.04)	.440(.12)	3.69**	.39
17	.177(.06)	.352(.14)	2.51**	.23
18	.174(.05)	.353(.14)	2.59**	.24
19	.185(.05)	.311(.13)	2.30	.20
20	.158(.04)	.306(.09)	3.45**	.36
21	.127(.04)	.363(.09)	3.90**	.42
22	.123(.04)	.374(.10)	3.70**	.39
23	.145(.04)	.291(.11)	2.74**	.26

*All t values are significant at the .05 level (one-tail test).
**Indicates significance at the .01 level (one-tail test).

Table 2

Results for the Regression
SDFUT = a + B(WISD)

Month	a(SE)	B(SE)	t*	R^2
1	.170(.08)	.579(.19)	3.07**	.31
2	.238(.09)	.368(.18)	2.00	.16
3	.199(.08)	.435(.17)	2.60**	.25
4	.166(.09)	.575(.20)	2.86**	.28
5	.207(.11)	.405(.21)	1.96	.15
6	.244(.08)	.292(.16)	1.79	.13
7	.276(.08)	.354(.18)	1.98	.16
8	.218(.08)	.439(.19)	2.28	.20
9	.208(.08)	.538(.22)	2.40	.22
10	.115(.07)	.718(.17)	4.15**	.45
11	.098(.09)	.833(.25)	3.33**	.35
12	.153(.08)	.617(.19)	3.20**	.33
13	.156(.09)	.570(.20)	2.83**	.28
14	.146(.07)	.575(.17)	3.44**	.36
15	.186(.06)	.410(.12)	3.29**	.34
16	.184(.05)	.321(.11)	3.05**	.31
17	.112(.05)	.391(.10)	3.75**	.41
18	.101(.06)	.345(.09)	3.78**	.40
19	.137(.06)	.290(.11)	2.76**	.27
20	.135(.04)	.351(.08)	4.16**	.45
21	.092(.04)	.403(.09)	4.56**	.50
22	.054(.05)	.499(.11)	4.52**	.49
23	.058(.05)	.481(.10)	4.59**	.50

*All t values are significant at the .05 level (one-tail test).
**Indicates significance at the .01 level (one-tail test).

The parameters estimated in Table 1 indicate that historic standard deviations (SDHISTs) explained approximately 26 percent (the average value of R^2 is .26) of the future standard deviations (SDFUTs) of stock returns. From Table 2 the corresponding value of R^2 for the weighted implied standard deviations (WISDs) obtained from option prices is .32. The increase is 23 percent and the trend in the increase is even more striking. During the first several months of the study trading of listed options was a relatively new experience for investors. Option trading on the Chicago Board Options Exchange began in April 1973. Until February 1974 the data indicate little difference between the predictive characteristics of historic standard deviations and those of standard deviations implied by option prices. Beginning in March 1974, less than a year after the start of listed option trading, the option implied standard deviations showed a sudden increase in predictive ability. They then begin to explain more of the future standard deviation of stock returns. The average value of R^2 for the remainder of the study increases to .39 as compared to .21 in the prior period. The regression using SDHIST does not indicate a significant trend in predictive ability over time. The evidence suggests that the predictive abilities of option implied standard deviations were continuing to improve during the entire period

under study. That evidence supports the hypothesis that the option market became more efficient as traders gained more experience. The t values in the tables relate to the testing of the hypothesis that the true values of B are greater than zero. Negative values of B may be ruled out on theoretical grounds. The higher the t value the lower is the probability that the sample could have been obtained from a distribution whose actual value of B was zero. The null hypothesis, that B equals zero, is rejected at the .05 significance level in each month for both regression models. The t values in Table 2 show a tendency to increase over time similar to the trend in the corresponding values of R^2.

Table 3 lists the estimates of the parameters B_1 and B_2, the corresponding t values and R^2 for the regression model SDFUT = a + B_1(WISD) + B_2(SDHIST). The tabulated values support the results obtained from the analysis of the first two regression models. The R^2 values are substantially higher than corresponding values in Table 2 for only three months (July, August and October 1973). After October 1973, the fifth month of twenty-three in this study, the multiple regression model does not produce substantially better values of R^2 than those obtained by use of the option implied standard deviations. The t values do not indicate consistently high levels of confidence as in the previous models. However, the t values for the

Table 3

Results for the Regression
$SDFUT = a + B_1(WISD) + B_2(SDHIST)$

Month	B_1	B_2	$t(B_1)$	$t(B_2)$	R^2
1	0.035	0.038	0.91	0.74	.33
2	-0.035	0.654	-0.14	2.10*	.31
3	0.048	0.601	0.17	1.62	.34
4	0.256	0.419	0.67	0.98	.31
5	-0.035	0.674	-0.11	1.67	.26
6	0.116	0.225	0.29	0.48	.14
7	0.221	0.172	0.73	0.54	.17
8	0.339	0.106	0.87	0.30	.20
9	0.612	-0.068	1.47	-0.21	.22
10	0.993	-0.295	3.58**	-1.26	.49
11	0.918	-0.070	2.28*	-0.27	.35
12	0.502	0.133	1.88*	0.64	.34
13	0.416	0.157	1.29	0.62	.29
14	0.648	-0.075	1.79*	-0.23	.36
15	0.401	0.013	1.68	0.05	.34
16	0.110	0.340	0.72	1.85*	.41
17	0.425	-0.051	2.40*	-0.24	.40
18	0.370	-0.042	2.35*	-0.20	.41
19	0.250	0.061	1.35	0.27	.27
20	0.290	0.072	1.88*	0.48	.46
21	0.317	0.099	1.87*	0.60	.51
22	0.381	0.128	2.19*	0.88	.51
23	0.482	-0.001	3.08**	-0.01	.50

*Indicates significance at the .05 level (one-tail test).
**Indicates significance at the .01 level (one-tail test).

coefficient of WISD are at a substantially higher value than those of the coefficients of SDHIST. After February 1974 the t values associated with the coefficients of SDHISTs deteriorate so markedly relative to those of the coefficients of WISDs that the use of the SDHIST values appears to add no information that is not already contained in the values of WISD.

Table 4 presents the regression parameters estimated by pooling all the observations into one "grand regression" for each model. First the regression parameters are presented for the "uncorrected" model. Results are distorted by possible violations of the basic assumptions of the classical normal linear regression model. The regression parameters presented in the lower half of Table 4 indicate the substantial improvement in the t values for each regression coefficient obtained by correcting each model for heteroskedasticity (variance of disturbances not consistent for all observations). The results are obtained by normalizing the data (subtracting the mean from each monthly value of WISD, SDHIST and SDFUT) and dividing the remainders by the standard error of their associated monthly regression. Mutual correlation (standard deviation of returns correlated between stocks) and autoregression (disturbances at one point in time carrying over into

Table 4

Results of Grand Regression

UNCORRECTED			
$SDFUT = a + B(WISD)$			
$a = .234$, $SE = .016$	$B = .281$, $SE = .034$		
$t(a) = 14.92$	$t(B) = 8.25$	$R^2 = .11$	
$SDFUT = a + B(SDHIST)$			
$a = .291$, $SE = .013$	$B = .204$, $SE = .038$		
$t(a) = 21.99$	$t(B) = 5.38$	$R^2 = .05$	
$SDFUT = a + B_1(WISD) + B_2(SDHIST)$			
$a = .234$, $SE = .016$	$B_1 = .296$, $SE = .048$	$B_2 = -.023$, $SE = .052$	
$t(a) = 14.86$	$t(B_1) = 6.10$	$t(B_2) = -.43$	$R^2 = .11$

Table 4--Continued

CORRECTED FOR HETEROSKEDASTICITY

$SDFUT^{\dagger} = B(WISD)^{\dagger}$

$B = .858$, $SE = .029$ $t = 29.92$ $R^{2\#} = .63$

$SDFUT^{\dagger} = B(HIST)^{\dagger}$

$B = .770$ $SE = .051$ $t = 15.22$ $R^2 = .31$

$SDFUT^{\dagger} = B_1(WISD)^{\dagger} + B_2(SDHIST)^{\dagger}$

$B_1 = .746$, $SE = .032$ $B_2 = .290$, $SE = .041$ $R^2 = .66$

$t(B_1) = 23.54$ $t(B_2) = 7.09$

†Indicates data values after transformation.
#The values of R^2 are not to be considered as equivalent to those for data which has not been transformed.

another period) are ignored.[1] Data in Table 4 support the conclusions previously obtained from the estimates of the monthly regression parameters. The t values are substantially higher for the coefficients of WISD values than for those of the SDHIST values. The analysis of the transformed multiple regression model results in an R^2 of .66, an increase of only .03 over the value of R^2 obtained using the WISDs alone. That tends to confirm the previous conclusion that the WISDs have been a better predictor of the future standard deviation of stock returns. Although the t statistic for the coefficient of SDHIST is significant, any additional information contained does not appear to adequately reward the extra effort required to include the SDHIST values in the analysis.

Conclusions

The information contained in Tables 1, 2, 3 and 4 provides substantial support for the hypothesis for the period of this study after February, 1974. The change in

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[1] It is also possible to correct for mutual correlation and autoregression by applying modified Aitkin's estimation formulas to the data after transformation as indicated by Kmenta [5, pp. 512-514]. However one of the steps would involve calculation of a variance-covariance matrix of the order 506X506. The analysis of data up to this point has provided very satisfactory results and this problem is left for future research.

the predictive characteristics over time is also an important discovery. The results of this study indicate that during the first five months covered by the Latané and Rendleman study the WISDs and the SDHISTs were both relatively poor indicators of the SDFUTs. However, during the last four months covered by their study the WISDs were clearly the superior predictors of SDFUTs.

The evidence presented in this chapter is strong. The conclusion of this researcher is that the WISDs have been substantially better predictors of SDFUTs than have the SDHISTs.

CHAPTER 3
A TEST OF THE EFFICIENCY OF THE OPTION MARKET AND THE ACCURACY OF THE EVALUATION MODEL

Introduction

In this chapter a trading strategy is developed which permits the testing of the efficiency of the CBOE and the accuracy of the evaluation model. A crucial underlying assumption is that the aggregate market assessment of volatility is the same for options of different maturities.

A hedge ratio must be calculated for each option in order to employ the trading strategy. To calculate the hedge ratio, the reciprocal of the derivative of the evaluation model with respect to the stock price $(\frac{dW}{dX})^{-1}$ is computed as follows:[1]

$$W = e^{-yt}XN(d_1) - e^{-rt}CN(d_2)$$

$$\frac{dW}{dX} = e^{-yt}N(d_1)$$

$$(\frac{dW}{dX})^{-1} = \frac{e^{yt}}{N(d_1)}$$

[1]The parameters of the equation are defined in Chapter 1, pages 6 and 8.

The derivative, $\frac{dW}{dX}$ above, represents the rate of price change in the option for an instantaneous price change in the underlying stock. If $\frac{dW}{dX}$ were equal to 0.2, a \$1.00 instantaneous increase in stock price would result, in theory, in a \$0.20 price increase in its option. Therefore, if one were to sell $(\frac{dW}{dX})^{-1}$ options for each share of stock held, the \$1.00 gain in the stock price would be offset by the loss of \$0.20 on each of the five options. Thus the hedge ratio is 5.0. The above example demonstrates the underlying principle of the evaluation model.

Discrepancies Between ISDs for Options on the Same Underlying Stock

The standard deviation of a stock's return is unique, therefore if the option market is perfectly efficient and the evaluation model is precise, all options on the same stock at a given time must have identical ISD values. However it may not be possible to record all option prices and their underlying stock prices simultaneously. Data available for this study contain values of closing transactions only.[1] A reported closing option price may not properly reflect the closing stock price because of the lack of a

[1]Exceptions occur when the last transaction of the option is outside the range of its closing bid and asked prices. In those cases the closing bid or asked price nearest the last transaction price is reported at the close of trading.

transaction following the last change in the stock price. The above factor may cause the calculated ISDs to differ on options having the same underlying stock. If the model is not properly specified and the market is inefficient, both those factors will create additional differences in the ISDs for options on the same stock. The above components of differences in the ISDs may be classified by type:

> Type 1. The component due to the closing stock price not being properly reflected in the closing option price
>
> Type 2. The component due to specification errors in the model, and
>
> Type 3. The component due to inefficiencies in the option market

It is possible to separate the combined effects of Type 1 and Type 3 components from those of Type 2. The procedure is developed in the following section.

Procedure for Establishing Risk-free Hedges

In Chapter 2 WISDs are calculated from the ISD values for all options on the same underlying security on a given observation date. In order to evaluate each of those options relative to the others and to create a profitable trading strategy the following steps are taken for each observation date:

1. An "implied market value" (IMV) is calculated for each option by using the value of its associated WISD in the evaluation equation
2. The observed option price is compared to the IMV
3. Options whose price exceeds the IMV by at least 10 percent are selected as "eligible short positions" (ESPs). Options for which the IMV exceeds their price by 10 percent or more are selected as "eligible long positions" (ELPs)
4. A risk-free hedge is created between an ESP and an ELP for each stock having at least one of each type of option. For stocks having several ESPs or ELPs the two options with the maximum percentage difference from the IMV are selected for the hedge
5. The amount of each option included in the hedged position is determined by the value of its hedge ratio so that each pair of options will produce offsetting gains and losses for an instantaneous movement in the underlying stock price[1]

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[1]The hedge ratio is the reciprocal of the derivative of the evaluation formula with respect to the stock price. It represents the number of option contracts which must

6. All option positions are closed one month later

An example of the above procedure follows:

A stock has five options with the following prices, IMVs and hedge ratios.

Option	Price	IMV	Price/IMV	Hedge Ratio
A	\$10.00	\$7.50	1.33	2.0
B	6.00	6.00	1.00	1.7
C	4.00	5.00	0.80	4.3
D	1.50	2.00	0.75	6.0
E	1.00	0.80	1.25	11.2

The A option has the highest price/IMV ratio. The D option has the lowest price/IMV ratio. A hedge is constructed in which six D options are long and two A options are short. Option D has a hedge ratio of 6.0. Its rate of price change relative to that of the stock is $0.1\overline{6}$ (the reciprocal of its hedge ratio). Option A has a rate of price change half that of its underlying stock. If the stock were to decline instantaneously by \$1.00 the above hedge, in theory, would produce offsetting gains and losses. The value of the position in A options would decline \$1.00, the value of the D options would also decline \$1.00.

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be sold per 100 shares of stock held in order for the instantaneous total dollar change in the value of the options sold to be equal to the instantaneous total dollar change in the stock position.

However since the A options are short, the $1.00 decline represents a $1.00 profit offsetting the loss incurred on the D options. If both options converged to their respective IMVs instantaneously the net profit would be $2.50 for each A option and $0.50 for each D option. The total gain from the hedge would be $8.00, $5.00 from the two A options and $3.00 from the six D options. Equal dollar hedges may be constructed while maintaining the latter ratio.[1]

The above strategy is used to create risk-free portfolios of hedges which eliminate the effect of stock price movements.[2] The anticipated gain results from the tendency of the price of each pair of options to approach a common ISD. The holding period for options in this study is one month which is required by the interval between observation dates. During the holding period the hedge ratios may change and thereby alter the risk characteristics of each hedge. That induced risk is diversified away by selection of many hedged positions over time.

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[1]In equal dollar hedges the sum of the long and the short positions is constant.

[2]Each hedge is risk-free only if traders price options according to the model and the positions are continously adjusted.

If the evaluation model is correct and the options return to equilibrium prices before the end of the month, the expected gain from the above hedge is $8.00, the same as for an instantaneous convergence to the IMV values. If the model is correct the total gain achieved from all the hedges should equal the sum of all expected gains.[1]

If the gain is larger than expected the options must have (on average) prices which differ from equilibrium more than the model indicates. If the gain is smaller than expected the opposite is true. The selection process favors the latter condition. Option prices which differ most from their IMVs will have a tendency to be those for which the model is most inaccurate. Therefore the options appearing to have the greatest discrepancy from their IMV will also have a tendency to be evaluated with maximum error.

The anticipated gains may be separated into two categories as illustrated in Figure 1:

1. Gains resulting from observed prices returning (on average) to equilibrium (Type 1 plus Type 3 components), and
2. Additional gains anticipated as a result of errors in the model (Type 2 component)

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[1]Assuming sufficient diversification.

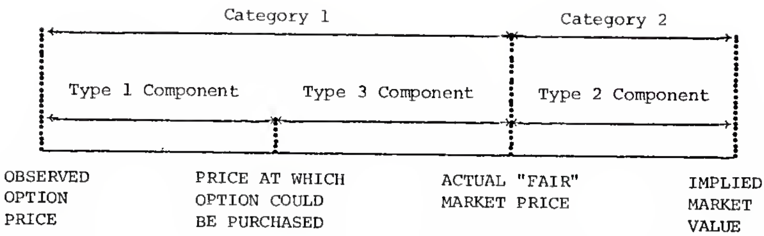

Figure 1. Categories of anticipated gains as related to components of differences in ISD values

By determining the gains expected from options returning to common ISD values and comparing them to realized gains, the above components can be identified. The difference is the Type 2 component. The realized gains represent the sum of the Type 1 and Type 3 components.

Hedge Results

The returns on each monthly portfolio of hedges are presented in Table 5. Data for individual hedges are presented in Appendix B. The percentage returns are related to the total dollar value of the hedge (the sum of the values of the long and the short positions). In _theory_ the returns are infinite because there is no net investment. The hedges may be adjusted so that the total dollar value of the long positions is exactly equal to the total

Table 5

Monthly Hedge Returns

Month	Number of Hedges	Portfolio Return (%)
1	1	19.28
2	0	---
3	0	---
4	1	10.30
5	4	8.43
6	8	17.19
7	4	-8.96
8	7	12.97
9	8	24.93
10	1	15.60
11	10	3.29
12	7	9.74
13	3	8.63
14	10	9.12
15	11	6.45
16	9	0.70
17	9	7.77
18	8	15.13
19	4	4.21
20	5	3.18
21	6	24.76
22	2	1.16
	Total 118	Mean 9.70

dollar value of the short positions. The proceeds from the sale of options are received by the seller and may be used to purchase other options. However, one must (due to institutional restrictions) deposit collateral. An investor having sufficient stock as collateral can hedge by using options without being required to make any additional cash deposit with a brokerage firm. The return on his stock portfolio is unaffected by the option transactions. The marginal return to his portfolio due to any gain on option transactions is infinite since the marginal investment is zero.

There are 22 holding periods between the 23 observation dates. During the first several months of the study the trading volume and the number of option contracts are low and hedging opportunities are few. During hedge periods 2 and 3 there are no selections. During each of periods 1, 4 and 10 there is only one hedge selected. Out of twenty periods for which one or more hedges are selected only one period showed a negative return. The return for equal initial dollar portfolios averaged 9.70 percent per month.

Other observations of interest from data in Appendix B follow:

1. Of 118 hedges 93 were profitable
2. The geometric rate of return resulting from a constant dollar position in each hedge is 9.69 percent per month

3. The average rate of return resulting from hedges in which the number of each option contract selected is equal to its hedge ratio is 9.96 percent per month
4. The anticipated return from the above hedging strategy is 17.45 percent per month
5. The portion of the anticipated gain which is realized is 57 percent, leaving 43 percent attributable to Type 2 error (error in the model)
6. The gain on the short positions is 134 percent of their anticipated returns
7. The gain on the long positions is minus 24 percent of their anticipated returns
8. There are 92 hedges between options of different maturities. For 72 of those hedges the option with the shortest time to maturity is selected as being the most overvalued

Discussion of Results

The returns are positive for 78.8 percent of the hedges and for 95 percent of the monthly portfolios. This indicates the power of the trading strategy. The various

methods of applying the hedge strategy (equal dollar hedges, equal dollar portfolios, etc.) produce similar returns.

The proportion of the reported gain relative to that inferred from the calculated IMVs is substantial. However, the test is unable to separate the returns due to Type 1 error from the returns which could have been earned from execution of transactions at the actual prices that could have been obtained in the option market.

To test whether it was possible to execute profitable transactions, Trippi (11, p. 97), in a similar study, examined returns obtained from simulated purchase of options at the opening prices on the day following the selection of potential profit opportunities. He selected 71 options as being potential profit opportunities during the period from April 7 through April 25, 1975. On the following days 37 options had opening prices which he considered favorable. The returns from simulated purchase at the opening prices of the "favorable" and "unfavorable" priced options were 80 to 90 percent of those reported from his hedges which used closing prices. The "favorable" group had one-week returns of 8.7 percent while the "unfavorable" group had one-week returns of 10.3 percent! Trippi did not calculate the anticipated rate of return for his selection process. However, the return from his trading strategy represented 66 percent of the minimum

potential.[1] For the trading rule developed in this study the returns are 100 percent of the minimum potential. That represents a 51-percent increase in calculated returns over that achieved by Trippi. The difference in the holding period should not bias the reported returns as the optimal holding period is expected to be less than one week. A holding period in excess of that necessary for options to return to equilibrium will only increase the induced risk which must be diversified away.

The substantial difference in the returns for the long and the short positions are primarily a result of the underlying stocks declining an average of 9.4 percent during the observation period. There is not sufficient information to determine whether options were overpriced or underpriced during the period.

Over 78 percent of the hedges included options having different maturities. Of those the option closest to maturity was selected for the short position 78 percent of the time. Thus for 61 percent of the hedges a shorter maturity option was selected as the most overpriced. If the selection process was totally random only 67 percent of hedges would be expected to have options of different

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[1]The minimum potential is the difference from an option's IMV necessary for it to meet the minimum requirement for selection. For Trippi's study that value averages 16.3 percent. For this study it is 10 percent.

maturities. Then only 33 percent of the hedges would have the shortest maturity option selected as the most overpriced. Therefore the actual number observed was nearly twice the expected number. That result is consistent with evidence presented by Merton (9). He examined the impact of an error in the assumption (crucial to the evaluation model) that stock returns are continuous.[1] He found:

> . . . the effect of specification error in the underlying stock returns on option prices will generally be rather small. . . . However, there are some important exceptions: short maturity options . . . can have significant discrepancies if a significant fraction of the total variability comes from the jump component . . . . [9, p. 345]

He also warns:

> . . . deep out of the money options which are greatly "overvalued" in percentage terms may not be overvalued at all if the underlying stock process includes jumps. [9, p. 343]

Conclusions

Trippi's follow-up test of the probability of initiating profitable hedge positions gives a strong indication that the majority of the gains from his trading strategy and of that presented in this study could be realized in

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[1]This implies that over a short period of time the stock price cannot change by very much. If the stock price "jumps," the instantaneous variance rate may be infinite.

practice. Thus the information available at present, although limited, leads to the conclusion that the CBOE was inefficient during the period covered by this study. The "captured" gains exceed commission costs. An individual may pay less than 4 percent if transactions are made through a discount brokerage firm.[1] Those in the best position to profit from inefficiencies in the option market are the members of the individual option exchanges.

The magnitude of the error in the evaluation model has been estimated. The anticipated return indicated by the model is 17.45 percent for the observation period. The simulated trading strategy "captured" more than half the discrepancy indicated by the model. The error attributable to the model is estimated at 43 percent of the anticipated gain or an average of a 7.49 percent price error. However, the options selected for inclusion in the trading strategy are expected to be those for which the model tends to be most inaccurate. Therefore the actual error is estimated to be much less than 7.49 percent.

The most overvalued options tended to be those which Merton has singled out for potential error in his evaluation. The error due to the existence of a jump component may cause those options to appear overvalued relative to

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[1]Commissions are a function of the option price and the amount invested. Discounts are offered by many firms and rates may often be negotiated.

other options. The tendency for options with shorter maturities to dominate the "overvalued" positions is consistent with the assumption that stock returns have a jump component.

The source and magnitude of inefficiencies in the option market and the errors in the evaluation model have been investigated in this work. Although the test results are not all conclusive other research supports the estimates of the magnitude of the various types of errors and inefficiencies defined in this study.

CHAPTER 4
SUMMARY AND CONCLUSIONS

Objective of Study

The major objective of this study is to obtain useful information from observations of stock option prices. Traditional approaches have generally attempted to calculate the price at which an option "should" trade. This study attempts to determine the informational content of observed option prices. Initially, it is assumed that the market prices of options may be more representative of "fair" values than prices calculated from evaluation models using historic stock variability as an input. Therefore the observed option prices are used as the input to the model and the stock variability becomes the output.

The secondary objective of this study is to use the variability inferred from the option prices to test the efficiency of the CBOE and also the accuracy of the evaluation model.

Chapter 1

Choice of Model

Evidence is presented which explains the rationale for the selection of the Black-Scholes model, as adjusted for dividends by Merton, for the option evaluation model in this study. The primary benefit of the dividend adjusted model is that it provides meaningful solutions of ISDs for many options for which the unadjusted Black-Scholes model has no solution. In addition the calculated ISDs for options on the same underlying stock are more consistent than ISDs calculated without correcting for dividends.

Related Studies

Weaknesses in the studies by Latané and Rendleman and by Trippi are noted and are corrected. Four major innovations are used to improve the results of the study by Latané and Rendleman:

1. An adjustment for dividends is included
2. A correction for the weighting of ISDs is developed
3. Observations of changes in the predictive characteristics of option prices over time are included
4. Many option data which have been excluded (due to the lack of a dividend adjustment) are included

To improve the results for the study by Trippi:

1. An adjustment for dividends is included
2. A correction for the weighting of ISDs is developed
3. A risk-free trading strategy is developed in lieu of portfolios of options with unknown risk, and
4. Ad hoc exclusion rules for certain classes of options are eliminated

Chapter 2

In Chapter 2 an improved weighting formula for obtaining WISDs is presented. The predictive characteristics of the WISDs versus those of the SDHISTs are tested. The method of ordinary least squares is used and the estimates of parameters for regression models are presented in tabular form. Test results indicate that the predictive characteristics of WISDs varied substantially during the observation period. Those of the SDHISTs did not appear to have a significant trend. During the period covered by the first nine months of this study there was no significant difference between the predictive characteristics of the WISDs and the SDHISTs. However, for the period covered by the last fourteen months of this study, the WISDs are clearly the superior predictors of the SDFUTs.

Chapter 3

In Chapter 3 a trading strategy is developed to test the efficiency of the CBOE and the accuracy of the evaluation model. Hedges are constructed between options on the same underlying stock such that (after diversification across stocks and over time) a riskless trading process is approached. The gain anticipated (assuming a perfect model) is divided into three components. The first component (Type 1) is created by option price data which does not properly reflect closing stock prices. The second component (Type 2) is a function of errors in the evaluation model. The third component (Type 3) is the result of inefficiencies in the option market (CBOE). The sum of the Type 1 and 3 components is estimated directly from the portion of expected gain "captured" by the trading strategy. Trippi's test of the magnitude of the gain achieved as a result of simulated purchases of options at opening prices is used to estimate the Type 1 component. Thus all three components can be estimated since the Type 2 component creates the remainder of the anticipated gain. The conclusion is that the CBOE was inefficient during the observation period and that the model error was small except for those options which had previously been identified by Merton as potential candidates for overvaluation.

Conclusions

There are several elements in this study which provide important new information:

1. The dividend adjustment and the improved weighting formula for ISDs provide better results than those achieved in previous studies
2. A trading strategy which approaches a riskless process over time can be achieved without requiring a position in the underlying stock
3. The hedging strategy can be implemented without any net investment
4. Use of historic stock price data for construction of option trading strategies will be unproductive if the WISDs continue to be the superior predictors in the future
5. Results of the trading strategy employed in this work may be improved by elimination of those options for which Merton indicates the model is most inaccurate
6. The Type 1 component can only be estimated with a high degree of accuracy if the trading strategy is employed by using

actual purchases and sales in the option market

There are further implications which are suggested from the results of this study:

1. The characteristics of predictive abilities of option prices may be better defined by
    a. use of SDHISTs and SDFUTs for other than twenty-month periods (i.e., three, six or nine months), and
    b. isolating classes of options (low priced, short maturity, etc.) which indicate, after testing, that their ISDs are not reliable indicators of SDFUTs
2. The gains "captured" by the trading strategy may be improved by
    a. using calculations of WISDs which exclude options as indicated in 1(b) above
    b. requiring a greater difference between the option price and the IMV for selection of hedged positions

3. Errors in the model may be better defined by constructing greater numbers of hedges and examining "captured" gains for various classes of options.

The results obtained indicate that the procedural innovations introduced in this study permit substantial improvements in tests of the evaluation model and of option market efficiency. The improved procedures will allow future empirical research in the above areas to be more productive.

APPENDIX A
VALUES OF WISD, SDHIST AND SDFUT FOR EACH STOCK ADJUSTED TO AN ANNUAL BASIS

STOCK 1
AMERICAN TELEPHONE

MONTH	WISD	SDHIST	SDFUT
1	0.1436	0.1152	0.2102
2	0.1860	0.1156	0.2103
3	0.2256	0.1153	0.2057
4	0.1421	0.1337	0.1926
5	0.2648	0.1441	0.1863
6	0.2229	0.1471	0.1867
7	0.1497	0.1545	0.1844
8	0.1125	0.1541	0.1843
9	0.1142	0.1535	0.1913
10	0.1227	0.1604	0.1886
11	0.2077	0.1644	0.1832
12	0.2019	0.1570	0.1900
13	0.2312	0.1552	0.1900
14	0.2457	0.1665	0.1674
15	0.2199	0.1635	0.1674
16	0.2464	0.1644	0.1713
17	0.1900	0.1894	0.1489
18	0.2739	0.1947	0.1349
19	0.2965	0.1957	0.1350
20	0.1931	0.2078	0.1227
21	0.2037	0.2102	0.1210
22	0.2862	0.2103	0.1186
23	0.2819	0.2057	0.1178

STOCK 2
ATLANTIC RICHFIELD

MONTH	WISD	SDHIST	SDFUT
1	0.3762	0.2950	0.2993
2	0.4139	0.2930	0.2989
3	0.3911	0.2692	0.3094
4	0.2921	0.2668	0.3047
5	0.4864	0.2720	0.2997
6	0.3953	0.2603	0.2977
7	0.4042	0.2641	0.2904
8	0.4041	0.2963	0.2607
9	0.2577	0.2842	0.2552
10	0.3206	0.2898	0.2514
11	0.2905	0.2709	0.2440
12	0.3093	0.2726	0.2433
13	0.2830	0.2712	0.2517
14	0.2978	0.2677	0.2579
15	0.2528	0.2709	0.2589
16	0.3221	0.2801	0.2477
17	0.2619	0.3089	0.1830
18	0.3397	0.2971	0.1841
19	0.3776	0.2975	0.1845
20	0.3549	0.2985	0.1984
21	0.3766	0.2993	0.1947
22	0.3349	0.2989	0.1940
23	0.3193	0.3094	0.1836

STOCK 3
BETHLEHEM STEEL

MONTH	WISD	SDHIST	SDFUT
1	0.4006	0.2809	0.3781
2	0.4087	0.2802	0.3926
3	0.4038	0.2664	0.4015
4	0.4658	0.3058	0.3820
5	0.5812	0.3062	0.3827
6	0.5344	0.3286	0.3640
7	0.4819	0.3466	0.3518
8	0.3699	0.3466	0.3574
9	0.2707	0.3320	0.3579
10	0.4209	0.3399	0.3517
11	0.3138	0.3365	0.3521
12	0.3712	0.3459	0.3818
13	0.3171	0.3403	0.3825
14	0.3617	0.2996	0.3869
15	0.4230	0.3010	0.3787
16	0.4403	0.3067	0.3669
17	0.3799	0.3218	0.3605
18	0.4579	0.3241	0.3643
19	0.4134	0.3271	0.3623
20	0.3022	0.3794	0.3164
21	0.3396	0.3781	0.3167
22	0.3560	0.3926	0.3007
23	0.3478	0.4015	0.2912

STOCK 4
BRUNSWICK

MONTH	WISD	SDHIST	SDFUT
1	0.6403	0.4611	0.7199
2	0.5986	0.5910	0.6293
3	0.6893	0.5913	0.6249
4	0.6651	0.5810	0.6286
5	0.6559	0.5755	0.6278
6	0.8691	0.7161	0.4368
7	0.7398	0.7264	0.4341
8	0.7075	0.7251	0.4415
9	0.5858	0.7364	0.4339
10	0.5908	0.7235	0.4463
11	0.5118	0.7249	0.4428
12	0.4777	0.7229	0.4745
13	0.5681	0.7178	0.4815
14	0.6338	0.7127	0.4432
15	0.7441	0.7071	0.4258
16	0.7464	0.6914	0.4044
17	0.7520	0.6939	0.4051
18	0.8205	0.7162	0.3889
19	0.7948	0.7162	0.3784
20	0.6300	0.7203	0.3448
21	0.6305	0.7199	0.3530
22	0.5407	0.6293	0.3380
23	0.5949	0.6249	0.3442

STOCK 5
EASTMAN KODAK

MONTH	WISD	SDHIST	SDFUT
1	0.2295	0.1604	0.3295
2	0.2778	0.1594	0.3329
3	0.1970	0.1528	0.3513
4	0.2835	0.1586	0.3508
5	0.3134	0.1482	0.3506
6	0.3181	0.1778	0.3398
7	0.2720	0.1777	0.3396
8	0.2982	0.1801	0.3373
9	0.2486	0.1744	0.3454
10	0.3127	0.1728	0.3491
11	0.2958	0.1679	0.3477
12	0.3623	0.1603	0.3499
13	0.3119	0.1586	0.3516
14	0.2757	0.1906	0.3350
15	0.3694	0.1865	0.3341
16	0.3397	0.2268	0.2926
17	0.4624	0.2458	0.2889
18	0.5597	0.2481	0.2769
19	0.4804	0.2479	0.2754
20	0.3352	0.2838	0.2620
21	0.3459	0.3295	0.2177
22	0.3210	0.3329	0.2150
23	0.3211	0.3513	0.1883

STOCK 6
EXXON

MONTH	WISD	SDHIST	SDFUT
1	0.2709	0.1472	0.2661
2	0.2895	0.1492	0.2671
3	0.2968	0.1585	0.2735
4	0.2849	0.1606	0.2787
5	0.3415	0.1606	0.2818
6	0.3040	0.1545	0.2830
7	0.2918	0.1560	0.2801
8	0.3067	0.1661	0.2724
9	0.2549	0.1684	0.2713
10	0.2843	0.1697	0.2719
11	0.2642	0.1666	0.2690
12	0.2683	0.1731	0.2630
13	0.3052	0.1720	0.2642
14	0.2622	0.1769	0.2655
15	0.3498	0.1927	0.2475
16	0.3024	0.1991	0.2168
17	0.3547	0.2395	0.1911
18	0.4077	0.2394	0.1695
19	0.3494	0.2405	0.1711
20	0.2524	0.2649	0.1526
21	0.2484	0.2661	0.1605
22	0.2801	0.2671	0.1568
23	0.2722	0.2735	0.1473

STOCK 7
FORD

MONTH	WISD	SDHIST	SDFUT
1	0.3893	0.2141	0.3150
2	0.3664	0.2154	0.3317
3	0.3619	0.2064	0.3318
4	0.3493	0.2131	0.3239
5	0.4395	0.2302	0.3258
6	0.4421	0.2685	0.2836
7	0.4203	0.2687	0.2821
8	0.3198	0.2885	0.2721
9	0.2884	0.2902	0.2852
10	0.2992	0.2935	0.2870
11	0.2655	0.2905	0.2882
12	0.2807	0.2945	0.3019
13	0.4095	0.2962	0.2997
14	0.3066	0.2808	0.2950
15	0.3131	0.2773	0.2818
16	0.3257	0.2777	0.2826
17	0.4544	0.2810	0.2548
18	0.5034	0.2811	0.2533
19	0.4441	0.2946	0.2530
20	0.2963	0.3084	0.2491
21	0.4912	0.3150	0.2324
22	0.4085	0.3317	0.2252
23	0.4241	0.3318	0.2338

STOCK 8
GULF AND WESTERN

MONTH	WISD	SDHIST	SDFUT
1	0.5147	0.3327	0.3004
2	0.5209	0.3448	0.2945
3	0.5092	0.3198	0.3021
4	0.4671	0.2772	0.2934
5	0.5741	0.2780	0.2999
6	0.5505	0.2839	0.2715
7	0.5034	0.2765	0.2719
8	0.3615	0.2837	0.2728
9	0.3595	0.2791	0.2733
10	0.4230	0.2758	0.2731
11	0.3793	0.2740	0.2694
12	0.4487	0.2822	0.2749
13	0.4570	0.2825	0.2727
14	0.3948	0.2881	0.2298
15	0.4346	0.2891	0.2491
16	0.3945	0.2794	0.2400
17	0.4581	0.2899	0.2362
18	0.6336	0.2922	0.2509
19	0.5490	0.3016	0.2436
20	0.3820	0.3007	0.2480
21	0.4328	0.3004	0.2526
22	0.4611	0.2945	0.2457
23	0.4779	0.3021	0.2402

STOCK 9
INA

MONTH	WISD	SDHIST	SDFUT
1	0.4357	0.3084	0.3067
2	0.4578	0.3116	0.3041
3	0.4334	0.3116	0.3084
4	0.4486	0.3104	0.3121
5	0.4509	0.3111	0.3232
6	0.4449	0.3207	0.3349
7	0.3819	0.3122	0.3319
8	0.2709	0.3183	0.3412
9	0.2693	0.3047	0.3585
10	0.3102	0.2849	0.3606
11	0.2774	0.2979	0.3421
12	0.2980	0.2999	0.3464
13	0.4297	0.2933	0.3288
14	0.4016	0.2906	0.3116
15	0.4534	0.2929	0.3035
16	0.5251	0.2899	0.3054
17	0.4685	0.3376	0.2728
18	0.4876	0.3364	0.2771
19	0.6111	0.3436	0.2678
20	0.3735	0.3334	0.2687
21	0.4470	0.3067	0.2687
22	0.4386	0.3041	0.2723
23	0.3247	0.3084	0.2797

STOCK 10
INTERNATIONAL HARVESTER

MONTH	WISD	SDHIST	SDFUT
1	0.4086	0.2949	0.3296
2	0.4697	0.2944	0.3252
3	0.5102	0.2936	0.3063
4	0.5150	0.2947	0.3246
5	0.5538	0.2933	0.3301
6	0.5484	0.3480	0.2795
7	0.5107	0.3232	0.2782
8	0.3961	0.3231	0.2844
9	0.3607	0.3249	0.2848
10	0.3629	0.3255	0.2889
11	0.3687	0.3081	0.3045
12	0.3699	0.3080	0.3412
13	0.4483	0.3114	0.3329
14	0.3703	0.3052	0.3320
15	0.4129	0.3072	0.3260
16	0.3876	0.2958	0.3221
17	0.4658	0.2981	0.3449
18	0.5070	0.2994	0.3486
19	0.4485	0.2647	0.3451
20	0.3877	0.2716	0.3469
21	0.4049	0.3296	0.3033
22	0.4062	0.3252	0.3064
23	0.4409	0.3063	0.3117

STOCK 11
KRESGE

MONTH	WISD	SDHIST	SDFUT
1	0.3722	0.2165	0.4835
2	0.6027	0.2270	0.4825
3	0.4905	0.2155	0.4887
4	0.4981	0.2357	0.4767
5	0.4566	0.2518	0.4783
6	0.4674	0.2905	0.4569
7	0.4053	0.2986	0.4539
8	0.3142	0.2954	0.4538
9	0.3000	0.2899	0.4637
10	0.4176	0.3021	0.4532
11	0.3087	0.3013	0.4538
12	0.3382	0.3186	0.4440
13	0.4157	0.3170	0.4443
14	0.3969	0.3452	0.4143
15	0.4401	0.3403	0.4117
16	0.4534	0.4138	0.2990
17	0.5585	0.4727	0.2388
18	0.6720	0.4682	0.2284
19	0.6125	0.4673	0.2236
20	0.4162	0.4841	0.2039
21	0.5441	0.4835	0.1764
22	0.5315	0.4825	0.1698
23	0.4849	0.4887	0.1670

STOCK 12
LOEW'S

MONTH	WISD	SDHIST	SDFUT
1	0.5081	0.2828	0.3942
2	0.6049	0.2928	0.3939
3	0.5539	0.2890	0.3832
4	0.4870	0.3038	0.4022
5	0.5416	0.2798	0.4037
6	0.5329	0.3020	0.3775
7	0.5737	0.3035	0.3804
8	0.4310	0.2986	0.3841
9	0.4358	0.2993	0.3840
10	0.4845	0.3054	0.3944
11	0.3800	0.3043	0.3941
12	0.5583	0.3403	0.4006
13	0.5602	0.3427	0.4006
14	0.4485	0.3241	0.3973
15	0.6211	0.3265	0.3854
16	0.6881	0.3176	0.3576
17	0.5949	0.3703	0.3384
18	0.6509	0.3765	0.3457
19	0.7331	0.3702	0.3505
20	0.4286	0.3916	0.3462
21	0.5130	0.3942	0.3517
22	0.5752	0.3939	0.3602
23	0.4856	0.3832	0.3715

STOCK 13
MCDONALD'S

MONTH	WISD	SDHIST	SDFUT
1	0.4749	0.2842	0.5903
2	0.3564	0.2919	0.5832
3	0.4084	0.2829	0.6114
4	0.3760	0.2811	0.6080
5	0.4542	0.2770	0.6102
6	0.5629	0.3868	0.5659
7	0.4818	0.3920	0.5568
8	0.4160	0.3860	0.5559
9	0.4264	0.3874	0.5638
10	0.4301	0.3876	0.5686
11	0.3843	0.3880	0.5686
12	0.4727	0.3879	0.5704
13	0.4073	0.3851	0.5595
14	0.4749	0.4177	0.5228
15	0.5527	0.3945	0.5179
16	0.5249	0.4631	0.4311
17	0.5780	0.5587	0.3450
18	0.8034	0.5559	0.3440
19	0.7220	0.5589	0.3207
20	0.4765	0.5727	0.3049
21	0.5390	0.5903	0.2823
22	0.4664	0.5832	0.2793
23	0.3986	0.6114	0.2242

STOCK 14
MERCK

MONTH	WISD	SDHIST	SDFUT
1	0.2541	0.1295	0.3677
2	0.3053	0.1298	0.3664
3	0.3655	0.1753	0.3535
4	0.3645	0.1732	0.3562
5	0.3704	0.1753	0.3547
6	0.3416	0.1748	0.3672
7	0.2985	0.1786	0.3687
8	0.2542	0.1810	0.3686
9	0.2403	0.1748	0.3768
10	0.2485	0.1633	0.3786
11	0.2315	0.1614	0.3919
12	0.3151	0.1619	0.3939
13	0.3129	0.1579	0.3973
14	0.2981	0.1980	0.3854
15	0.3068	0.1941	0.3837
16	0.3787	0.2484	0.3320
17	0.4074	0.3425	0.2589
18	0.4930	0.3428	0.2586
19	0.5001	0.3392	0.2590
20	0.3767	0.3393	0.2606
21	0.3581	0.3677	0.2298
22	0.3309	0.3664	0.2622
23	0.2928	0.3535	0.2660

STOCK 15
NORTHWEST AIRLINES

MONTH	WISD	SDHIST	SDFUT
1	0.5981	0.4105	0.4951
2	0.6468	0.4225	0.4770
3	0.7208	0.4267	0.4760
4	0.5965	0.4523	0.4488
5	0.7244	0.4413	0.4459
6	0.6801	0.4487	0.4325
7	0.6076	0.4437	0.4319
8	0.5085	0.4351	0.4377
9	0.4405	0.4541	0.4136
10	0.4921	0.4470	0.4358
11	0.4295	0.4475	0.4395
12	0.4486	0.4336	0.4856
13	0.5744	0.4271	0.4826
14	0.5169	0.4273	0.4777
15	0.6619	0.4332	0.4617
16	0.6146	0.4569	0.4062
17	0.7129	0.4504	0.3970
18	0.8549	0.4415	0.3791
19	0.7873	0.4509	0.3586
20	0.5298	0.4888	0.3091
21	0.6173	0.4951	0.3156
22	0.5371	0.4770	0.3141
23	0.5252	0.4760	0.3096

STOCK 16
PENNZOIL

MONTH	WISD	SDHIST	SDFUT
1	0.5100	0.3790	0.4545
2	0.6377	0.3768	0.4529
3	0.6026	0.3515	0.4506
4	0.5091	0.3862	0.4184
5	0.6232	0.3836	0.4198
6	0.6080	0.3754	0.4158
7	0.4544	0.3903	0.3961
8	0.4648	0.3882	0.3996
9	0.3772	0.3881	0.3998
10	0.4204	0.3834	0.3927
11	0.4391	0.3531	0.3878
12	0.5118	0.4431	0.3076
13	0.5052	0.4268	0.3164
14	0.5341	0.4267	0.3290
15	0.6265	0.4273	0.3262
16	0.6183	0.4327	0.2955
17	0.5902	0.4663	0.2524
18	0.6161	0.4712	0.2571
19	0.5871	0.4689	0.2728
20	0.4940	0.4498	0.2733
21	0.4478	0.4545	0.2739
22	0.5003	0.4529	0.2685
23	0.4782	0.4506	0.2695

STOCK 17
POLAROID

MONTH	WISD	SDHIST	SDFUT
1	0.3621	0.3132	0.6214
2	0.4184	0.3173	0.6444
3	0.4424	0.3305	0.6946
4	0.4368	0.3216	0.6994
5	0.5865	0.3009	0.7134
6	0.5356	0.3573	0.6930
7	0.5183	0.3381	0.6939
8	0.4142	0.3699	0.6754
9	0.3597	0.3657	0.6812
10	0.5440	0.3896	0.6684
11	0.4877	0.3926	0.6739
12	0.6264	0.4994	0.6103
13	0.5727	0.4762	0.6059
14	0.6441	0.4940	0.5733
15	0.7486	0.4961	0.5503
16	0.6920	0.5426	0.4447
17	0.7968	0.6208	0.3799
18	0.9723	0.6175	0.3830
19	0.9193	0.6151	0.3620
20	0.6053	0.6230	0.3658
21	0.7291	0.6214	0.4055
22	0.6314	0.6444	0.3972
23	0.6089	0.6946	0.3518

STOCK 18
RCA

MONTH	WISD	SDHIST	SDFUT
1	0.5089	0.2436	0.4088
2	0.5377	0.2577	0.4092
3	0.5242	0.2413	0.4072
4	0.4695	0.2555	0.4468
5	0.5128	0.2528	0.4465
6	0.6497	0.3203	0.3934
7	0.5739	0.3213	0.3952
8	0.4631	0.3258	0.3950
9	0.4384	0.3306	0.3925
10	0.3613	0.3288	0.3999
11	0.4358	0.3318	0.3873
12	0.4632	0.3320	0.4408
13	0.5227	0.3284	0.4379
14	0.5321	0.3409	0.3916
15	0.5027	0.3466	0.4032
16	0.6662	0.3526	0.3608
17	0.6193	0.3511	0.3594
18	0.7009	0.3516	0.3611
19	0.6872	0.3504	0.3628
20	0.5415	0.4014	0.3421
21	0.4647	0.4088	0.3505
22	0.5309	0.4092	0.3462
23	0.5522	0.4072	0.3435

STOCK 19
SPERRY RAND

MONTH	WISD	SDHIST	SDFUT
1	0.4178	0.2809	0.3355
2	0.4374	0.2660	0.3206
3	0.5198	0.2633	0.3476
4	0.4417	0.2423	0.3508
5	0.5419	0.2397	0.3598
6	0.4555	0.2436	0.3691
7	0.4189	0.2445	0.3664
8	0.4009	0.2093	0.3614
9	0.3284	0.2090	0.3676
10	0.3881	0.2112	0.3654
11	0.3387	0.2074	0.3705
12	0.3898	0.2088	0.3891
13	0.3609	0.2073	0.3900
14	0.4178	0.2312	0.3734
15	0.4869	0.2385	0.3615
16	0.4824	0.2694	0.3200
17	0.5277	0.3181	0.2973
18	0.6162	0.3185	0.3056
19	0.5479	0.3085	0.3015
20	0.3708	0.3303	0.2884
21	0.3711	0.3355	0.2895
22	0.3445	0.3206	0.2935
23	0.3996	0.3476	0.2600

STOCK 20
TEXAS INSTRUMENTS

MONTH	WISD	SDHIST	SDFUT
1	0.4681	0.2047	0.4248
2	0.4349	0.2518	0.3912
3	0.5635	0.2394	0.4167
4	0.3637	0.2465	0.4075
5	0.6303	0.2450	0.4082
6	0.4987	0.2614	0.4148
7	0.4747	0.2557	0.4128
8	0.3527	0.2526	0.4119
9	0.3193	0.2546	0.4161
10	0.4210	0.2774	0.4043
11	0.3549	0.2780	0.4035
12	0.3973	0.2892	0.4262
13	0.3839	0.3172	0.4060
14	0.3616	0.3322	0.3896
15	0.3553	0.3280	0.3952
16	0.3297	0.3864	0.3178
17	0.3918	0.4123	0.3022
18	0.5250	0.4096	0.3124
19	0.5172	0.4129	0.3096
20	0.3447	0.4145	0.3081
21	0.4230	0.4248	0.3125
22	0.4605	0.3912	0.3073
23	0.3777	0.4167	0.2741

STOCK 21
UPJOHN

MONTH	WISD	SDHIST	SDFUT
1	0.4839	0.2557	0.5618
2	0.4648	0.2727	0.5475
3	0.5112	0.2905	0.5555
4	0.4502	0.2920	0.5589
5	0.4616	0.2678	0.5542
6	0.4456	0.2692	0.5757
7	0.4585	0.3190	0.5653
8	0.4534	0.3367	0.5659
9	0.3760	0.3122	0.5748
10	0.4633	0.3039	0.5812
11	0.3380	0.3130	0.5730
12	0.4170	0.3153	0.5766
13	0.4316	0.3188	0.5835
14	0.3938	0.3193	0.5869
15	0.4628	0.3282	0.5832
16	0.4652	0.4235	0.5207
17	0.6147	0.4245	0.5263
18	0.6563	0.4157	0.5246
19	0.5318	0.4114	0.5252
20	0.7044	0.5412	0.3369
21	0.5781	0.5618	0.3252
22	0.5197	0.5475	0.3251
23	0.5539	0.5555	0.3194

STOCK 22
WEYERHAEUSER

MONTH	WISD	SDHIST	SDFUT
1	0.3763	0.2092	0.3250
2	0.4683	0.2147	0.3183
3	0.4275	0.2175	0.3263
4	0.3496	0.2127	0.3333
5	0.5208	0.2053	0.3303
6	0.5124	0.2121	0.3348
7	0.5281	0.2152	0.3267
8	0.3585	0.2009	0.3379
9	0.3061	0.1916	0.3400
10	0.2796	0.1916	0.3390
11	0.2750	0.1903	0.3337
12	0.3664	0.2337	0.3376
13	0.3641	0.2381	0.3369
14	0.3462	0.2418	0.3480
15	0.3615	0.2523	0.3394
16	0.3640	0.3150	0.2647
17	0.4956	0.3163	0.2623
18	0.5417	0.3067	0.2638
19	0.5518	0.3091	0.2656
20	0.3532	0.3241	0.2507
21	0.3936	0.3250	0.2507
22	0.3978	0.3183	0.2506
23	0.3712	0.3263	0.2387

STOCK 23
XEROX

MONTH	WISD	SDHIST	SDFUT
1	0.2577	0.1633	0.4412
2	0.2762	0.1633	0.4389
3	0.3002	0.1457	0.4439
4	0.3568	0.1593	0.4438
5	0.2978	0.1575	0.4419
6	0.3486	0.1904	0.4388
7	0.3520	0.1910	0.4390
8	0.2768	0.1743	0.4408
9	0.2558	0.1751	0.4457
10	0.3085	0.1692	0.4491
11	0.3555	0.1724	0.4511
12	0.2731	0.1867	0.4960
13	0.3574	0.1858	0.4973
14	0.3796	0.2314	0.4931
15	0.3776	0.2442	0.4900
16	0.3674	0.2927	0.4589
17	0.4405	0.3138	0.4615
18	0.6333	0.3362	0.4360
19	0.5795	0.3458	0.4188
20	0.3618	0.4417	0.3380
21	0.5057	0.4412	0.3363
22	0.4602	0.4389	0.3359
23	0.4948	0.4439	0.3329

APPENDIX B
OPTION DATA FOR HEDGED POSITIONS

APPENDIX B
OPTION DATA FOR HEDGED POSITIONS

MO.	STK.	DAYS OPT. LIFE	OPT. EXER. PRICE	INIT. OPT. PRICE	IMPL. MKT. VAL.	END OPT. PRICE	INIT. $ POSIT.	PROFIT OR LOSS	RETURN ON HEDGE(%)
1	15	207	25	2.38	2.10	3.75	5.72	-3.31	
		207	30	1.00	1.18	2.38	3.73	5.13	19.28
4	19	119	45	10.13	8.96	9.75	13.31	0.49	
		210	55	5.25	5.90	6.25	10.07	1.92	10.30
5	6	86	100	4.63	4.13	1.25	11.34	8.27	
		177	100	6.00	6.98	3.75	12.71	-4.76	14.59
5	7	86	60	2.13	1.90	0.19	7.05	6.43	
		177	60	3.25	3.65	0.69	8.27	-6.52	-0.61
5	17	86	110	7.63	6.46	0.56	19.53	18.09	
		177	130	5.50	6.79	1.50	16.92	-12.30	15.87
5	19	86	40	14.63	13.18	8.00	16.66	7.55	
		177	55	6.25	7.02	2.75	11.53	-6.46	3.86
6	5	56	140	0.75	0.42	0.13	10.78	8.98	
		147	140	2.00	2.67	1.63	8.98	-1.68	36.95
6	7	56	50	0.94	0.63	0.13	5.32	4.61	
		147	50	1.63	2.03	0.88	5.15	-2.38	21.33
6	8	56	30	0.63	0.45	0.13	3.51	2.81	
		147	30	1.19	1.52	0.75	3.54	-1.30	21.33
6	10	56	30	0.75	0.54	0.44	3.66	1.52	
		238	35	1.63	2.17	1.00	4.58	-1.76	-2.91
6	12	56	25	0.50	0.34	0.31	2.93	1.10	
		147	25	1.00	1.16	0.88	3.12	-0.39	11.67
6	19	56	55	1.25	1.04	0.31	5.40	4.05	
		238	55	4.00	4.71	2.25	8.90	-3.89	1.11
6	22	56	60	15.50	13.14	18.50	18.40	-3.57	
		56	70	5.00	6.58	10.00	8.43	8.43	18.13

MO.	STK.	DAYS OPT. LIFE	OPT. EXER. PRICE	INIT. OPT. PRICE	IMPL. MKT. VAL.	END OPT. PRICE	INIT. $ POSIT.	PROFIT OR LOSS	RETURN ON HEDGE (%)
6	23	56	160	0.69	0.40	0.06	12.12	11.02	
		147	160	2.13	2.91	1.25	10.39	-4.28	29.93
7	4	208	20	1.50	1.76	1.38	3.68	-0.31	
		208	15	3.50	3.18	2.88	5.74	1.02	7.59
7	5	117	140	1.63	1.38	0.63	10.32	6.35	
		208	140	3.00	3.49	1.50	11.29	-5.64	3.27
7	7	117	40	4.13	3.65	6.13	7.59	-3.67	
		208	60	0.63	0.71	0.63	4.72	-0.00	-29.86
7	17	117	70	10.50	8.82	15.00	17.90	-7.67	
		208	110	1.75	2.54	2.38	8.86	3.16	-16.83
8	4	176	20	1.38	1.53	1.31	3.56	-0.16	
		176	25	0.88	0.77	0.63	3.83	1.10	12.65
8	10	176	30	1.19	1.35	1.19	3.49	-0.00	
		176	25	3.50	3.10	3.38	5.84	0.21	2.22
8	11	85	40	0.56	0.47	0.50	3.12	0.35	
		176	40	1.13	1.29	1.31	3.66	0.61	14.11
8	12	85	25	0.50	0.41	0.25	2.59	1.30	
		85	20	1.50	1.88	1.25	2.58	-0.43	16.72
8	13	85	70	0.88	0.71	0.19	6.27	4.93	
		176	70	1.50	2.24	1.25	5.57	-0.93	33.75
8	17	85	110	0.81	0.72	0.13	8.13	6.88	
		176	110	2.38	2.70	0.88	10.51	-6.64	1.29
8	23	85	140	1.50	1.16	0.38	10.02	7.51	
		176	140	3.13	3.59	1.63	11.20	-5.38	10.08
9	4	57	20	0.63	0.56	0.25	2.34	1.41	
		148	20	1.31	1.49	1.06	3.22	-0.61	14.23
9	5	57	120	0.63	0.39	0.56	7.23	0.72	
		239	120	3.25	3.96	5.38	9.96	6.52	42.13
9	6	57	90	1.75	1.43	0.38	6.11	4.80	
		148	100	1.06	1.22	0.75	5.90	-1.73	25.55

MO.	STK.	DAYS OPT. LIFE	OPT. EXER. PRICE	INIT. OPT. PRICE	IMPL. MKT. VAL.	END OPT. PRICE	INIT. $ POSIT.	PROFIT OR LOSS	RETURN ON HEDGE(%)
9	9	57	40	0.69	0.55	0.13	2.74	2.24	
		148	40	1.25	1.44	0.94	3.30	-0.76	24.63
9	12	57	25	0.25	0.18	0.13	2.14	1.07	
		57	20	1.25	1.39	1.31	2.31	0.11	26.58
9	17	57	95	0.94	0.76	0.06	6.67	6.23	
		148	110	0.88	1.01	0.50	7.14	-3.06	22.92
9	18	57	25	0.38	0.22	0.06	2.75	2.29	
		148	20	2.00	2.44	1.38	3.39	-1.06	20.07
9	21	57	75	1.38	1.23	0.75	5.93	2.70	
		148	75	3.25	3.57	3.63	8.67	1.00	25.30
10	7	117	60	0.63	0.49	0.44	4.79	1.44	
		117	50	2.13	2.72	2.13	4.42	-0.00	15.60
11	4	87	20	0.44	0.32	0.25	2.48	1.06	
		87	15	1.31	1.66	1.00	2.23	-0.53	11.33
11	5	87	120	1.63	1.30	1.31	9.26	1.78	
		87	100	6.75	7.76	9.25	10.73	3.97	28.77
11	9	87	35	0.50	0.44	0.19	2.45	1.53	
		87	30	1.94	2.15	0.88	3.11	-1.70	-3.09
11	10	87	30	0.56	0.49	0.25	2.67	1.48	
		87	25	1.81	2.06	1.25	3.11	-0.97	8.97
11	11	87	35	1.06	0.96	2.63	3.23	-4.74	
		178	35	1.75	1.94	3.75	4.02	4.59	-2.13
11	12	87	20	1.25	1.37	0.25	2.39	-1.91	
		178	25	0.75	0.64	0.19	3.13	2.35	7.89
11	13	87	70	0.63	0.50	0.56	5.67	0.56	
		87	50	5.88	6.53	2.25	8.22	-5.07	-32.46
11	14	87	90	1.25	1.04	0.88	5.86	1.76	
		87	80	4.00	4.49	4.00	6.69	0.00	14.04
11	17	87	80	0.88	0.80	0.13	6.87	5.89	
		178	80	2.25	2.62	0.31	8.73	-7.52	-10.45

MO.	STK.	DAYS OPT. LIFE	OPT. EXER. PRICE	INIT. OPT. PRICE	IMPL. MKT. VAL.	END OPT. PRICE	INIT. $ POSIT.	PROFIT OR LOSS	RETURN ON HEDGE(%)
11	20	87	120	1.75	1.50	3.75	9.94	-11.35	
		178	100	9.75	10.83	18.00	16.55	14.00	10.01
12	6	147	70	6.00	6.74	4.88	9.22	-1.73	
		238	80	4.13	3.75	3.00	10.49	2.86	5.76
12	9	147	35	0.69	0.48	0.25	3.80	2.42	
		147	30	1.06	1.66	0.63	2.30	-0.95	24.15
12	10	56	30	0.25	0.20	0.06	2.07	1.55	
		56	25	1.25	1.45	0.56	2.34	-1.29	5.99
12	12	56	20	0.25	0.20	0.13	1.93	0.97	
		147	20	0.69	0.77	0.50	2.44	-0.66	6.95
12	16	147	20	1.13	1.25	1.13	2.89	-0.00	
		238	25	0.94	0.84	0.75	3.74	0.75	11.23
12	18	56	20	0.25	0.18	0.13	1.89	0.94	
		147	20	0.63	0.70	0.38	2.21	-0.88	1.53
12	22	56	35	5.00	4.39	2.75	6.41	2.89	
		56	40	1.25	1.64	0.50	2.86	-1.72	12.60
13	11	117	30	6.50	5.86	1.69	8.41	6.23	
		208	35	4.00	4.44	1.31	6.90	-4.63	10.40
13	13	117	60	1.50	1.29	0.19	6.66	5.83	
		208	60	2.38	2.76	0.75	7.13	-4.88	6.88
13	17	117	40	3.25	2.73	0.63	7.98	6.45	
		208	45	2.75	3.09	0.81	7.28	-5.13	8.62
14	3	177	35	1.19	1.30	0.81	3.76	-1.19	
		268	30	3.75	3.23	2.88	6.93	1.62	4.03
14	6	86	80	1.63	1.89	0.69	4.95	-2.86	
		268	70	10.00	9.09	7.00	14.85	4.45	8.07
14	8	86	20	1.06	1.19	1.31	2.24	0.52	
		177	25	0.69	0.60	0.81	3.04	-0.55	-0.49
14	11	86	30	1.69	1.52	1.00	3.93	1.60	
		268	30	3.25	3.61	3.25	5.89	0.00	16.34

MO.	STK.	DAYS OPT. LIFE	OPT. EXER. PRICE	INIT. OPT. PRICE	IMPL. MKT. VAL.	END OPT. PRICE	INIT. $ POSIT.	PROFIT OR LOSS	RETURN ON HEDCE(%)
14	12	86	20	0.25	0.19	0.25	1.98	0.00	
		86	15	1.13	1.41	0.88	1.97	-0.44	-10.98
14	13	86	50	0.75	0.66	0.38	4.71	2.36	
		177	50	1.75	1.97	1.44	5.99	-1.07	12.02
14	14	86	80	0.88	0.67	0.13	6.10	5.23	
		177	80	1.63	2.06	0.88	6.02	-2.78	20.22
14	17	86	25	5.25	4.61	1.81	7.73	5.06	
		177	40	1.50	1.74	0.63	5.26	-3.07	15.35
14	20	86	100	1.56	1.31	0.38	8.66	6.58	
		268	90	8.00	8.89	7.13	15.43	-1.69	20.30
14	23	86	120	1.50	1.04	0.13	11.57	10.61	
		268	100	10.13	11.91	5.25	18.12	-8.72	6.34
15	3	147	35	0.81	0.92	0.25	3.32	-2.30	
		238	30	2.88	2.61	1.56	6.16	2.81	5.39
15	6	56	80	0.69	0.60	0.06	5.04	4.58	
		238	80	3.50	3.98	0.63	9.62	-7.90	-22.65
15	7	56	45	0.63	0.52	0.06	3.10	2.79	
		238	45	2.13	2.39	0.88	5.33	-3.13	-4.08
15	10	56	25	0.25	0.18	0.06	2.07	1.55	
		147	20	2.00	2.27	1.44	3.40	-0.96	10.88
15	11	56	30	1.00	0.84	2.13	3.23	-3.64	
		147	35	0.75	0.94	1.75	3.08	4.10	7.33
15	13	56	35	3.88	3.26	0.06	6.82	6.71	
		238	40	4.38	5.21	0.63	8.34	-7.15	-2.90
15	15	56	20	1.06	0.88	0.06	3.12	2.94	
		147	25	0.81	0.97	0.13	3.01	-2.55	6.36
15	16	147	15	3.50	3.15	1.38	5.25	3.19	
		238	20	1.75	2.03	0.75	3.88	-2.22	10.61
15	17	56	20	4.00	3.60	0.13	5.82	5.64	
		147	40	0.63	0.74	0.19	3.76	-2.63	31.37

MO.	STK.	DAYS OPT. LIFE	OPT. EXER. PRICE	INIT. OPT. PRICE	IMPL. MKT. VAL.	END OPT. PRICE	INIT. $ POSIT.	PROFIT OR LOSS	RETURN ON HEDGE(%)
15	21	56	75	1.56	1.22	0.06	7.53	7.23	
		147	85	1.31	2.02	0.13	5.95	-5.38	13.69
15	23	147	80	12.13	10.92	1.38	18.25	16.18	
		238	100	5.25	5.97	0.75	13.35	-11.44	15.00
16	5	207	100	0.75	0.54	1.88	9.37	-14.04	
		207	70	4.25	5.59	10.50	8.57	12.60	-8.03
16	9	116	25	1.00	1.23	3.00	2.87	5.75	
		207	20	4.25	3.79	8.00	6.63	-5.84	-0.99
16	11	116	25	0.56	0.48	2.63	2.84	-10.42	
		207	25	0.81	1.08	3.63	2.63	9.10	-24.16
16	13	116	30	1.63	1.34	7.25	4.97	-17.20	
		207	40	0.63	0.80	4.00	3.47	18.76	18.51
16	19	116	25	2.38	2.70	6.50	4.25	7.38	
		207	30	2.25	2.05	4.38	5.69	-5.38	20.10
16	20	116	80	0.63	0.53	3.38	5.94	-26.13	
		207	80	1.38	1.62	6.50	6.51	24.27	-14.91
16	21	116	50	3.13	2.77	4.25	7.97	-2.87	
		207	65	1.31	1.51	2.25	6.40	4.57	11.85
16	22	207	30	1.25	1.39	3.00	3.57	5.00	
		207	35	0.63	0.56	1.56	3.64	-5.45	-6.36
16	23	116	90	0.75	0.45	1.88	9.34	-14.01	
		207	90	1.19	1.52	4.00	6.61	15.65	10.30
17	3	85	30	1.19	1.35	0.81	2.91	-0.92	
		267	30	3.00	2.54	2.75	6.42	0.54	-4.12
17	5	85	90	1.75	1.47	0.50	9.31	6.65	
		176	100	1.88	2.29	1.38	9.03	-2.41	23.13
17	8	85	20	2.25	2.56	3.50	3.39	1.89	
		176	25	1.63	1.40	2.38	4.41	-2.04	-1.93
17	9	176	20	8.00	7.14	8.50	9.40	-0.59	
		267	30	2.38	2.83	3.00	5.15	1.36	5.29

MO.	STK.	DAYS OPT. LIFE	OPT. EXER. PRICE	INIT. OPT. PRICE	IMPL. MKT. VAL.	END OPT. PRICE	INIT. $ POSIT.	PROFIT OR LOSS	RETURN ON HEDGE(%)
17	10	85	20	1.75	1.94	1.69	3.05	-0.11	
		267	20	3.50	3.15	3.38	5.89	0.21	1.12
17	11	85	20	5.75	5.23	4.50	7.06	1.53	
		176	30	1.94	2.28	1.88	4.73	-0.16	11.67
17	16	85	15	2.88	3.23	4.25	3.85	1.84	
		267	15	4.88	4.39	5.75	6.85	-1.23	5.71
17	21	85	65	1.19	0.97	1.06	7.60	0.80	
		176	75	1.25	1.62	1.50	6.72	1.34	14.93
17	22	176	35	1.56	1.98	1.88	4.35	0.86	
		267	25	8.38	6.81	7.38	11.51	1.37	14.12
18	5	56	70	4.38	3.84	0.75	10.43	8.64	
		238	80	6.25	7.27	4.38	14.35	-4.31	17.50
18	6	56	70	2.00	1.74	0.50	6.74	5.06	
		238	70	4.88	5.54	4.63	10.92	-0.56	25.44
18	11	56	25	2.00	1.74	0.50	4.51	3.38	
		147	25	3.00	3.37	2.25	5.62	-1.40	19.53
18	13	56	30	7.25	6.42	1.88	10.09	7.48	
		147	40	4.50	5.11	1.75	9.08	-5.55	10.07
18	17	56	30	1.06	0.97	0.06	4.40	4.14	
		238	25	4.75	5.52	3.00	8.03	-2.96	9.50
18	19	147	35	2.25	2.50	1.13	5.74	-2.87	
		238	30	5.88	5.34	3.75	10.04	3.63	4.82
18	22	56	30	2.25	2.05	0.38	4.65	3.87	
		147	30	3.25	3.65	2.88	5.94	-0.68	30.14
18	23	56	80	1.25	1.10	0.06	7.96	7.56	
		147	90	1.88	2.60	0.31	8.29	-6.91	4.03
19	5	115	90	0.88	0.96	0.69	6.83	-1.46	
		206	60	12.25	10.94	15.25	18.83	-4.62	-23.69
19	7	115	40	0.88	1.05	0.88	3.51	0.00	
		206	35	3.75	3.32	3.63	7.69	0.26	2.32

MO.	STK.	DAYS OPT. LIFE	OPT. EXER. PRICE	INIT. OPT. PRICE	IMPL. MKT. VAL.	END OPT. PRICE	INIT. $ POSIT.	PROFIT OR LOSS	RETURN ON HEDGE(%)
19	20	115	90	1.38	2.18	0.81	6.22	-2.54	
		206	60	17.25	15.13	17.25	23.87	-0.00	-8.45
19	21	115	75	0.63	0.87	0.06	4.79	-4.31	
		206	45	12.38	11.15	1.94	17.38	14.66	46.67
20	1	266	50	2.00	2.27	3.63	4.54	3.69	
		266	45	5.50	4.66	6.75	8.00	-1.81	14.94
20	3	175	30	2.63	2.88	2.38	4.43	-0.42	
		175	25	6.88	6.14	5.25	7.94	1.88	11.73
20	16	175	20	1.63	1.79	2.25	3.49	1.35	
		175	15	4.63	4.17	5.50	5.97	-1.13	2.28
20	21	84	40	2.13	1.46	1.63	7.80	1.84	
		175	50	1.13	1.58	1.25	4.87	0.54	18.73
20	23	84	90	0.75	0.56	1.88	7.28	-10.91	
		84	70	4.88	5.42	8.25	8.51	5.89	-31.79
21	4	56	15	0.38	0.23	0.25	2.22	0.74	
		147	10	2.25	2.56	3.50	3.15	1.76	46.53
21	5	56	100	1.50	1.17	0.88	7.86	3.28	
		238	90	8.00	9.52	11.00	14.45	5.42	38.98
21	7	56	35	1.38	1.58	2.50	3.48	2.84	
		56	30	4.50	3.91	7.13	6.39	-3.73	-9.00
21	17	56	25	1.31	1.14	1.13	3.95	0.56	
		238	25	3.38	3.84	4.38	6.42	1.90	23.73
21	21	56	45	0.75	0.66	0.56	4.36	1.09	
		147	50	1.25	1.45	1.63	5.40	1.62	27.78
21	23	56	90	1.88	1.42	0.13	9.74	9.09	
		147	80	6.50	7.47	4.38	13.34	-4.36	20.51
22	7	116	40	1.75	2.03	1.31	4.44	-1.11	
		207	35	5.75	5.04	4.75	9.33	1.62	3.74
22	16	116	20	1.56	1.78	1.50	3.15	-0.13	
		116	15	5.13	4.58	5.13	6.07	-0.00	-1.42

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BIOGRAPHICAL SKETCH

Donald P. Chiras was born in Worcester, Massachusetts, on November 8, 1938. He graduated from Classical High School there in 1957. He attended the United States Naval Academy and was commissioned an Ensign upon graduation in 1961.

After completion of air navigation training he was assigned to Project Magnet, an airborne geomagnetic survey, which charts the earth's magnetic field. While serving in this capacity, Mr. Chiras developed a method of reducing gyro-compass drift which increased navigational accuracy. That led to his role as a navigator in planning and executing the pioneering single-aircraft flight across the uncharted wastes of the Antarctic Continent and the treacherous waters of the South Atlantic Ocean. He received the Navy Commendation Medal for the flight which was the first in history to prove the feasibility of air travel between the Eastern and Western Hemispheres via trans-Antarctic routing. He was then selected as the first in his graduation class to return to the Naval Academy to instruct midshipmen. There he received the highest fitness report rating of any officer-instructor.

After leaving the Navy in 1967 he was awarded a College of Engineering Fellowship at the University of Florida where he received a master's degree in mechanical engineering in 1968. He accepted a position with Shell Oil Co. as a project engineer responsible for the design, construction and profitability analysis of offshore oil production projects. After becoming the offshore division electrical engineer he proved the economic feasibility of the introduction of gas turbine generators (modified jet engines) to provide electric power generation for offshore oil production platforms.

Mr. Chiras then joined Merrill Lynch, Pierce, Fenner and Smith, Inc. for five years as an account executive where he became research liaison and a member of the Executive's Club. Upon his departure in 1974 he became a registered investment advisor and financial consultant and accepted a Graduate Council Fellowship at the University of Florida to pursue his doctorate in business administration with a major in finance.

In 1977, he accepted a position as a visiting assistant professor in the Department of Finance, Insurance and Real Estate at the University of Florida where he will teach investments. He is currently managing investment portfolios and is active in personal financial consulting.

He has received notice of his inclusion in the 1977 edition of Who's Who in Business and Finance.

He is married to the former Gloria L. Perez, who is an assistant professor of nursing at the University of Florida. They have one child, Jennifer, age 5.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

W. M. Howard

William M. Howard, Chairman
Professor of Finance and Insurance

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Roger D Blair

Roger D. Blair
Associate Professor of Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

David A Drake

David A. Drake
Associate Professor of Mathematics

This dissertation was submitted to the Graduate Faculty of the Department of Finance, Insurance and Real Estate in the College of Business Administration and to the Graduate Council, and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August 1977

Dean, Graduate School